METRIC/INCH POUND

GP-435
Volume I
REVISION F

ENGINEERING DRAWING PRACTICES

VOLUME I OF II

AEROSPACE AND GROUND SUPPORT EQUIPMENT

February 28, 2001

SPACEPORT ENGINEERING AND TECHNOLOGY DIRECTORATE

National Aeronautics and
Space Administration

John F. Kennedy Space Center

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GP-435
Volume I
REVISION F

ENGINEERING DRAWING PRACTICES

VOLUME I OF II

AEROSPACE AND GROUND SUPPORT EQUIPMENT

Approved:

Original Signed by

_____

Kenneth J. Payne
Acting Director of Spaceport Engineering
and Technology

February 28, 2001

JOHN F. KENNEDY SPACE CENTER, NASA

RECORD OF REVISIONS/CHANGES

REV LTR	CHANGE NO.	DESCRIPTION	DATE
		Basic Issue	August 1, 1973
A		General Revision	December 18, 1978
	A-1	Changed Revision 18, Interface Control Documents	July 2, 1979
	A-2	Changed paragraph 10.5.3.1 (f) Changed Section 16, Reference Designations	October 31, 1980
B		General Revision	May 31,1984
	B-1	Changed paragraph 10.6.5.4	January 9.1987
C		General Revision	March 5, 1991
	C-1	Miscellaneous Changes to Sections I, II, III, IV, VII, and IX	March 30, 1992
D		Revised to incorporate the metric system	March 1, 1993
E		Revised to incorporate minor miscellaneous changes to all sections	June 2, 1997
	E-1	Changed paragraphs 9.2.1.3 and 9.2.1.4	December 3, 1997
	E-2	Change Notice to make pen-and-ink change to page 9-5, paragraph 9.2.1.3 (blocks)	September 11, 1998
	E-3	Change Notice to make pen-and-ink change to page 9-2, paragraph 9.2.1.3 (block 1)	March 23, 1999
	E-4	Change notice to make pen-and-ink changes to page 8-1, paragraphs 8.2 and 8.3	July 2, 1999
F		General revision to incorporate changes E-1 thru E-4, and to update references, drawing format changes, drafting practices, and drawing and part identification	February 28, 2001

LIST OF EFFECTIVE PAGES

Insert latest changes; destroy superseded pages

NOTE

The portion of the text affected by the change is indicated
by a vertical line in the outer margin of page.

TOTAL NUMBER OF PAGES IN THIS DOCUMENT IS 242, CONSISTING OF:

FOREWORD

This document establishes the requirements, procedures, and practices for the preparation, release, revision, change, maintenance, and control of engineering drawings prepared for or by the John F. Kennedy Space Center (KSC), NASA. This document applies to those KSC engineering drawings used to fabricate, construct, install, modify, test, operate, maintain, and otherwise utilize aerospace and ground support equipment (GSE) and facilities at KSC. These requirements, procedures, and practices do not apply to the preparation of illustrations, artwork, or figures in technical publications.

The purpose of this document is to establish uniform engineering practices and methods for the preparation and revision of engineering drawings used at KSC. This document is not intended for use as a text of drafting fundamentals or for the recording of design data or criteria. The figures and drawings shown herein are primarily intended to illustrate the particular drafting practice under consideration and do not illustrate complete working drawings. KSC engineering design best practices shall be in accordance with KSC-DE-512-SM and are not included in this document.

Volume I of this manual applies to aerospace and ground support engineering drawings, and volume II applies to facilities engineering drawings.

Requests for information or for making corrections or additions to this manual should be directed to the Spaceport Engineering and Technology Directorate, Mail Code: YA, Kennedy Space Center, Florida 32899. Requests for additional copies of this document should be sent to the Forms Warehouse, Kennedy Space Center, Florida 32899.

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ABBREVIATIONS AND ACRONYMS

AC, ac	alternating current
AES	advanced electrical schematic
AIIM	Association for Information and Image Management
AM-NAT	American National Standard Thread designation
AMS	Aerospace Materials Specification
AN	Air Force/Navy, Army/Navy
ANSI	American National Standard Institute
AR	as required
ASSY	assembly
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWA	automatic wiring analyzer
AWS	American Welding Society
BD	block diagram
CAD	computer-aided design/drafting
CAGE	Commercial and Government Entity
CCBD	Configuration Control Board Directive
CDR	critical design review
CDS	central data system
CID	cable interconnect diagram
CMDS	Configuration Management Data System
DC, dc	direct current
DIA	diameter
DOD	Department of Defense
DRA	Document Release Authorization
DWG	drawing
DXF	designation for drawing interchange file
EDC	Engineering Documentation Center
EES	elementary electrical schematics
e.g.	for example
EHS	extra-high-strength steel
EMCD	electromechanical control diagram
EO	engineering order
ESR	Engineering Support Request
etc.	and so forth
FED	Federal
GA	gauge
GIS	ground integrated schematic
GOAL	Ground Operations Aerospace Language
GPM	gallons per minute

ABBREVIATIONS AND ACRONYMS (cont)

GSE	ground support equipment
HCD	hardware interface module configuration document
HCDS	hardware interface module configuration document system
HIM	hardware interface module
ICD	interface control document (or drawing)
i.e.	that is
IGES	Initial Graphics Exchange Specification
in	inch
INC	incorporated
INSTL	installation
IPC	Institute for Interconnecting and Packaging Electronic Circuits
IRN	interface revision notice
JSC	Lyndon B. Johnson Space Center
kPa	kilopascal
KSC	John F. Kennedy Space Center
KSI	kips per square inch
lb	pound
LCC	Launch Control Center
LC-39	Launch Complex 39
LOX, LO_2	liquid oxygen
LPS	Launch Processing System
LRU	line-replaceable unit
MATL	material
MF	microfilm
MFR	manufacturer's
MIL	military
MLP	Mobile Launcher Platform
mm	millimeter
MPa	megapascal
MS	military standard
MSFC	George C. Marshall Space Flight Center
NAS	National Aerospace Standard
NASA	National Aeronautics and Space Administration
No.	number
NTS	not to scale
OMD	operations and maintenance documentation
OMRSD	operation and maintenance requirements and specifications document
OPF	Orbiter Processing Facility
PDR	preliminary design review

ABBREVIATIONS AND ACRONYMS (cont)

PR	Problem Report
QTY	quantity
Ra	roughness average
REQD	required
REV	revision
SAE	Society of Automotive Engineers
Sh, sht	sheet
SI	International System of Units
SID	standard interface document
SMR	source maintenance and repair
SMS	system mechanical schematic
SPEC	specification
SPECSINTACT	specifications kept intact
STD	standard
SUB	subtract
Subassy	subassembly
SYM	symbol
TDRS	Tracking and Data Relay Satellite
UNF	unified fine (thread series)
UNS	unified numbering system
UTS	ultimate tensile strength
VAB	Vehicle Assembly Building
VPF	Vertical Processing Facility
WILMA	Wire List Maintenance (system)
YA	Spaceport Engineering and Technology Directorate
μF	microfarad
Ω	ohm

SECTION I

INTRODUCTION

1.1 SCOPE

This manual establishes the requirements, procedures, and practices for the preparation, release, revision, modification, maintenance, and control of engineering drawings prepared for or by the John F. Kennedy Space Center (KSC), NASA. Volume I of this manual applies to those drawings used to fabricate, construct, install, test, operate, maintain, and otherwise utilize aerospace and ground support equipment (GSE) at KSC. Volume II applies to drawings used to construct, test, operate, maintain, and otherwise utilize facilities at KSC. These requirements do not apply to the preparation of illustrations, artwork, or figures in technical publications. KSC engineering design practices shall be in accordance with KSC-DE-512-SM and are not included in this document.

To establish uniform engineering practices and methods for the preparation and revision of aerospace and ground support equipment engineering drawings used at KSC, volume I provides:

a. Drafting practices including mechanical and electrical conventions

b. Drawing formats

c. Types of engineering drawings

d. Procedures for the creation of titles for drawings

e. Methods for revision and change of drawings

f. Procedures for numbering and identification of drawings and part identification

1.2 DRAFTING METHODS

The requirements, procedures, and practices specified herein shall be followed in preparation of drawings by both manual drafting and computer-aided drafting (CAD) methods. Selection of the appropriate drafting method to be used shall be made by the responsible design organization. CAD hardware and software may be used to prepare drawing layouts, details, and formats.

1.3 DRAWING CLASS

The class of a drawing shall be determined by the responsible design organization, based upon the purpose and intent of the drawing and upon operational requirements.

1.3.1 NONMAINTAINED DRAWINGS. Nonmaintained drawings are prepared for defining design criteria, performing studies, design evaluation, initial construction, fabrication or modification, installation, and qualification and acceptance testing of facilities, systems, and equipment. Upon completion of fabrication, installation, construction, or modification, nonmaintained drawings shall be revised to document the as-built configuration and may be revised to maintain the configuration. As-built drawings, when revised, must conform to section IX of this volume. Engineering Orders (EO's) may be issued to change nonmaintained drawings when it is more cost effective to change a drawing than to produce a modification drawing.

1.3.2 MAINTAINED DRAWINGS. Maintained drawings are prepared to document facility, system, and equipment hardware and software configurations. Maintained drawings shall be kept up to date through revisions and the issuance of EO's to the drawings. Changes made by EO shall be incorporated into maintained drawings when the number of outstanding EO's exceed 10. Maintained drawings include operations and maintenance documentation (OMD).

1.3.3 MEASUREMENT UNITS. This document contains values in both metric and U.S. Customary units. In many cases, the two values shown for the same criterion are not exact conversions of each other. The metric conversions are rounded, rational values that provide reasonable guidelines when working in metric units in the same manner as the customary units provide guidelines for working in nonmetric units. Therefore, when performing drawing functions for metric projects, the metric values shown shall be used exclusively. Likewise, when performing drawing functions for nonmetric projects, the customary values shown shall be used exclusively. The customary values shall not be soft-converted to metric for use on metric projects or vice versa.

1.4 APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. When this document is used for procurement, including solicitations, or is added to an existing contract, the specific revision levels, amendments, and approval dates of said documents shall be specified in an attachment to the Solicitation/Statement of Work/Contract.

1.4.1 GOVERNMENTAL

National Aeronautics and Space Administration (NASA)

NASA-SPEC-5004	Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities, Specification for

1.4.1.1 Specifications.

John F. Kennedy Space Center (KSC), NASA

KSC-E-165	Electrical Ground Support Equipment, Specification for
KSC-W-167	Wiring Programming System Patchboards, Specification for
KSC-SPEC-Z-0002	Welding, Aluminum Alloy Pipe, Tubing and Associated Fittings, Specification for
KSC-SPEC-Z-0005	Brazing,Steel, Copper, Aluminum, Nickel, and Magnesium Alloys, Specification for
KSC-SPEC-Z-0013	Penetrant, Magnetic Particle and Ultrasonic Inspection, Requirements for, Specification for

Federal

A-A-208	Ink, Marking, Stencil, Opaque (Porous and Non-Porous Surfaces)
A-A-50557	Primer, Water-Borne, Acrylic or Modified Acrylic, for Metal Surfaces
A-A-50570	Paint, Water-Borne, Acrylic or Modified Acrylic, Semigloss, for Metal Surfaces
A-A-56032	Ink, Marking, Epoxy Base
L-P-00519	Plastic Sheet, Tracing, Glazed and Matte Finish
QQ-C-320	Chromium Plating (Electrodeposited)
QQ-N-290	Nickel Plating (Electrodeposited)
QQ-P-416	Plating, Cadmium (Electrodeposited)UU-P-561 Paper, Tracing

Military

MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys

MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-DTL-16232	Phosphate Coating, Heavy, Manganese, or Zinc Base (for Ferrous Metals)
MIL-I-46058C	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
MIL-PRF-23827	Grease, Aircraft and Instrument, Gear and Actuator Screw, NATO Code Number G-354, Metric
MIL-S-22473	Sealing, Locking, and Retaining Compounds (Single Component)

U.S. Department of Commerce National Bureau of Standards

	Initial Graphics Exchange Specification (IGES) Version 4.0 or subsequent versions

1.4.1.2 Standards.

John F. Kennedy Space Center (KSC), NASA

KSC-STD-152-2	Graphic Symbols for Drawings, Part 2; Ground Support Equipment, Standard for
KSC-STD-C-0001	Protective Coating of Carbon Steel, Stainless Steel and Aluminum on Launch Structures, and Ground Support Equipment, Standard for
KSC-STD-E-0010	Soldering of Electrical Connections (Hand or Machine)
KSC-STD-E-0015	Marking of Ground Support Equipment, Standard for
KSC-STD-P-0001	Equipment Procurement/Performance Specifications, Preparation of
KSC-STD-P-0002	Component/Performance Specification, Preparation of

George C. Marshall Space Flight Center (MSFC), NASA

MSFC-STD-156	Riveting, Fabrication and Inspection
MSFC-STD-349	Electrical and Electronics Reference Designations

Federal

FED-STD-595	Colors Used in Government Procurement

Military

MIL-STD-12	Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents
MIL-STD-34	Preparation of Drawings for Optical Elements and Optical Systems, General Requirements for
MIL-STD-171	Finishing of Metal and Wood Surfaces
MIL-STD-870	Cadmium Plating, Low Embrittlement, Electrode position
MIL-STD-889	Dissimilar Metals
MIL-STD-961	Department of Defense Standard Practice Defense Specifications
MIL-STD-2175	Castings, Classification and Inspection of
MS-18068	Setscrew, Hexagon Socket, Cone Point, 250 Deg F Self-Locking Element, Corrosion Resisting Steel, Passivated
MS-33537	Insert, Screw Thread, Helical Coil, Coarse and Fine Thread, Standard Assembly Dimensions for

1.4.1.3 Drawings.

John F. Kennedy Space Center (KSC), NASA

75M50393	Identification Plate, KSC GSE

79K09579	KSC Facilities, Systems, and Equipment Organizational Level OMD Baseline

1.4.1.4 Procedures.

Spaceport Engineering and Technology Directorate (YA)

DL-NED No. 009	Procedure for HIM Configuration Document and GSE Function Designator Generation
KDP-KSC-P-1537	Document Release Authorization (DRA) Process

1.4.1.5 Publications.

National Aeronautics and Space Administration (NASA)

NASA TM-103575	Space Transportation System and Associated Payloads: Glossary, Acronyms, and Abbreviations

John F. Kennedy Space Center (KSC), NASA

KSC-DE-512-SM	Facility, System and Equipment General Design Requirements

Military

DOD 5220.22-M	National Industrial Security Program Operating Manual
Cataloging Handbook H4/8	Commercial and Government Entity (CAGE)

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.

1.4.2 NON-GOVERNMENTAL.

Aerospace Industries Association of America. Inc., National Aerospace Standard (NAS)

NAS 523	Fastener Code

NASM 33540	Safety Wiring and Cotter Pinning, General Practices for
NASM 8177	Fasteners, Blind, High Strength, Installation Formed, Alloy Steel, General Specification for

(Application for copies should be addressed to the Aerospace Industries Association of America, Inc., 1250 Eye Street, N.W., Washington, DC 20005)

American National Standards Institute/Association for Information and Image Management (ANSI/AIIM)

ANSI/AIIM MS 5	Microfiche
ANSI/AIIM MS 32	Standard Recommended Practice - Microrecording of Engineering Source Documents on 35 mm Microfilm

(Application for copies should be addressed to the Association for Information and Image Management, 1100 Wayne Ave., Suite 1100, Silver Springs, MD 20910-5603)

American National Standards Institute/American Welding Society (ANSI/AWS)

ANSI/AWS A2.4	Standard Symbols for Welding, Brazing and Nondestructive Examination
ANSI/AWS A3.0	Standard Welding Terms and Definitions

(Applications for copies should be addressed to the American Welding Society, Inc., 550 N.W. LeJeune Rd., Miami, FL 33126)

American National Standards Institute/Association Connecting Electronics Industries (ANSI/IPC)

ANSI/IPC-D-325	Documentation Requirements for Printed Boards, Assemblies, and Support Drawings

(Applications for copies should be addressed to Association Connecting Electronics Industries, 2215 Sanders Rd., Northbrook, IL 60062-6135)

American Society of Mechanical Engineers (ASME)

ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)

ASME B4.2	Preferred Metric Limits and Fits
ASME B4.3	General Tolerances for Metric Dimensioned Products
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME B94.6	Knurling
ASME Y14.100M	Engineering Drawing Practices
ASME Y14.1	Decimal Inch Drawing Sheet Size and Format
ASME Y14.2M	Line Conventions and Lettering
ASME Y14.3M	Multi and Sectional View Drawings
ASME Y14.5M	Dimensioning and Tolerancing
ASME Y14.6	Screw Thread Representation
ASME Y14.6AM	Screw Thread Representation (Metric Supplement)
ASME Y14.7.1	Gear Drawing Standards - Part 1: For Spur, Helical, Double Helical, and Rack, Partial Revision of
ASME Y14.7.2	Gear and Spline Drawing Standards - Part 2: Bevel and Hyped Gears
ASME Y14.8M	Castings and Forgings
ASME Y14.13M	Mechanical Spring Representation
ASME Y14.18M	Optical Parts
ASME Y14.36M	Surface Texture Symbols, Revision of

ASME Y14.38	Abbreviations and Acronyms - for Use on Drawings and in Text

(Application for copies should be addressed to the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5902)

American Society for Testing and Materials (ASTM)

ASTM A325M	High-Strength Bolts for Structural Steel Joints, Standard Specification for
ASTM A490	Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength, Standard Specification for
ASTM A967	Stainless Steel Parts, Chemical Passivation Treatments for, Standard Specification for
ASTM B456	Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium, Standard Specification for
ASTM D3955	Electrical Insulating Varnishes, Standard Specification for
ASTM SI-10	Standard for Use of the International System of Units (SI): The Modern Metric System

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959)

Society of Automotive Engineers (SAE)

SAE AMS-H-6875	Heat Treatment of Steel Raw Materials
SAE AMS-M-3171	Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on
SAE AMS-STD-2175	Castings, Classification and Inspection of
SAE AS-71051	Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT – Design and Inspection Standards

SAE HS 1086	Metals & Alloys in the United Numbering System

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15906-0001)

1.5 DEFINITIONS

For the purposes of this manual, the following definitions shall apply:

a. Altered Part/Item. A part/item that, prior to the alteration, is taken from existing Government stock or procured from a vendor and altered to meet design requirements. The item is then altered to meet specific design requirements.

b. Assembly. A number of parts or subassemblies or any combination thereof joined together to perform a specific function (e.g., power shovel-front, fan assembly, audio-frequency amplifier, etc.).

NOTE

The distinction between an assembly and a subassembly is determined by individual application. An assembly in one instance may be a subassembly in another where it forms a portion of a higher assembly.

c. Bulk Materials. Those necessary constituents of an assembly or part such as oil, wax, solder, cement, ink, damping fluid, grease, powered graphite, flux, welding rod, thread, twine, and chain for which the quantity required is not readily predeterminable; or if the quantity is known, the physical nature of the material is such that it is not adaptable to depiction on a drawing; the material can be cut to finished size by the use of such hand or bench tools as shears, pliers, knives, etc., without any further machining operations, and the configuration is such that it can be fully described in writing without the necessity of pictorial representation.

d. Cancelled Drawing. A drawing that has been replaced, superseded, or duplicated by another drawing of a different number.

e. Component. The smallest assembled item identifiable as a complete, functioning hardware entity that performs a distinctive function in the operation of an item of equipment or a system.

f. Commercial and Government Entity (CAGE) Code. A five-digit alphanumeric code applicable to all organizations that have produced or are producing items used by the Federal Government. It also applies to Government organizations that control the de-

sign of items or are responsible for the development of certain specifications, drawings, or standards that control the design of items. These numbers are assigned in conformance with Cataloging Handbook H4/8. Organizations not assigned a CAGE code shall request such an identification in conformance with Cataloging Handbook H4/8. Organizations that neither manufacture nor control design (such as dealers, agents, or vendors of items produced by others) are not included in Cataloging Handbook H4/8.

g. Document. A specification, drawing, list, standard, pamphlet, report, and printed, typewritten, or other information relating to the design, procurement, manufacture, test, or inspection of items or services under a contract.

h. Drawing Format. A format in accordance with an accepted standard used for the preparation of an engineering drawing.

i. Drawing Number. Letters, numbers, or combination of letters and numbers (which shall not be separated by dashes) that are assigned to a particular drawing for identification purposes by the design organization.

j. Drawing Title. The name by which the part or item shall be known and will consist of a basic name with sufficient modifiers to differentiate it from like items in the same major assembly.

k. Duplicate Original. A replica of an original engineering drawing made by a photoduplicating technique, or a combination of a photoduplicating technique and drafting on a medium (vellum, plastic base material, paper, etc.) suitable for reproducing other reproducible and nonreproducible drawings.

1. Engineering Drawing. An engineering document that discloses (directly or by reference) by means of pictorial or textual presentations, or combinations of both, the physical and functional end-product requirements of an item.

m. Equipment Drawing. A drawing that defines controlled elements in terms of procurement, manufacture, installation, test and checkout, or spares provisioning.

n. Facility. Building, structure, site, or related construction that is built, installed, or established to serve a particular purpose.

o. Find number. A number that may be assigned to an item (part, assembly, etc.) on the field of a drawing for the purpose of cross-referencing to items on a parts list, and as a locator in lieu of using the item part number. The parts, assemblies, etc., so marked have other identifying numbers for purposes of procurement and marking, which are cross-referenced to the find numbers in the parts lists or in a table on the drawing. Find numbers will be used on all assembly or installation drawings. Find numbers

shall be cross-referenced to part numbers in a parts list located preferably on sheet 1 of the drawing.

p. Flag. A triangular symbol with an enclosed note number or letter that may be used with leaders to indicate the location on the field of the drawing where a note applies. The applicable note in the list of notes shall also have its note number or letter placed within a flag.

q. Graphic Symbol. A simple delineation of an item or component, which is intended to emphasize its function and operation in a circuit.

r. Ground Support Equipment. All equipment necessary to support the operations of receiving, handling, assembly, test, checkout, service, and launch of space vehicles.

s. Item. A nonspecific term used to denote any unit or product including materials, parts, assemblies, equipment, accessories, and attachments.

t. Interface Control Drawing. A drawing that defines the physical/functional interface between participating activities and provides the means to evaluate and control all mutually interacting design parameters at interfaces between the equipment and facilities of these activities.

u. Maintained Drawing. A drawing that contains design data that must be kept up to date in order to meet an operational need.

v. "May". An expression of allowance for a nonmandatory provision.

w. Nonmaintained Drawing. A drawing that contains design data that need not be kept up to date.

x. Obsolete Drawing. A drawing that depicts design information which is of no further use.

y. Operations and Maintenance Documentation (OMD). Drawings, schematics, specifications, diagrams, flowcharts, and lists required for operations and maintenance of facilities, systems, and equipment.

z. Original Date. The original date (located in the title block) of an entire basic issue is used to establish a baseline and is retained throughout the life of the drawing for historical record purposes. The current revision date is used for new inserted/added sheets when added to an existing drawing. All sheets added on the same revision will have the same date.

aa. Original Drawing. The drawing or copy thereof on which is kept the revision record and is recognized as the official copy by the design organization.

ab. Part. One piece or two or more pieces joined together, which are not normally subject to disassembly without destruction or impairment of designed use (e.g., outer front wheel bearing of a 3/4-ton truck, electron tube, composition resistor, screw, gear, mica capacitor, audio transformer, milling cutter, etc.).

ac. Part Number. Letters, numbers, or combinations of letters and numbers (which may be separated by dashes) that are assigned to uniquely identify a specific item. The part number shall be or shall include the design drawing number, and may include a dash number suffix (if applicable).

ad. Referenced Document. A referenced document (as used in this manual) is a design organization standard, drawing, specification, pamphlet, or other document referenced on a drawing or list.

ae. Revision. Any change to an original drawing after that drawing has been released for use.

af. Revision Symbol. An identifying letter that may be accompanied by a suffix number and enclosed in a circle or may be the printed letter in a revision column or block.

ag. "Shall". An emphatic form of the verb that is used whenever a requirement is intended to express a provision that is binding and mandatory.

ah. "Should". An expression of strong recommendation of a nonmandatory provision.

ai. Specification. A document that clearly and accurately describes the essential technical requirements for specific items, services, or processes to be supplied and establishes the necessary criteria and/or procedures to ensure that requirements have been met.

aj. Standard. A document that establishes engineering and technical requirements for items, materials, processes, practices, and methods that have been adopted as norms for specific use. A standard may also establish design criteria and requirements for the selection and application of items, materials, etc., and criteria for achieving required interchangeability and uniformity.

ak. Subassembly. Two or more parts that form a portion of an assembly or a unit replaceable as a whole, but having a part or parts that are individually replaceable (e.g., window sash, floating piston, telephone dial, intermediate frequency strip, terminal board with mounted parts, etc.).

al. Subsystem. A major functional subassembly or grouping of items or equipment that is essential to the operational completeness of a system.

am. System Drawing. A drawing showing the overall management/configuration of the system it supports, conforming with the intended usage of the appropriate drawing type. Typical system drawings are systems schematics, single-line diagrams, and plant-in-place records. For the purpose of this procedure, interface control drawings/system interface drawings that are prepared to define physical/functional and procedural interfaces are considered system drawings.

an. System (general). A composite of equipment, skills, and techniques capable of performing or supporting an operational role, or both. A complete system includes all equipment, related facilities, materials, software, services, and personnel required for its operation and support to the degree that it can be considered a self-sufficient unit in its intended operational environment.

ao. System Schematic. A drawing that delineates the interconnection of a complete system and specifies point-to-point connections, electrical or mechanical components, input/output sources, wire size, etc., as required. System schematics are produced for launch-critical systems that require detailed equipment definition.

ap. Unit. An assembly or any combination of parts, subassemblies, and assemblies mounted together and normally capable of independent operation in a variety of situations (e.g., hydraulic jack, electric motor, electronic power supply, internal combustion engine, electric generator, radio receiver).

aq. Vendor. A design firm, manufacturer, seller, wholesaler, or agent from whom items are acquired for use in the performance of a contract.

ar. "Will". An expression of declaration of purpose and is used where simple futurity is required for a provision that will be binding and mandatory.

SECTION II

GENERAL DRAFTING PRACTICES

2.1 SCOPE

This section defines the general drafting practices that shall be used in the preparation of aerospace and ground support equipment (GSE) drawings at KSC. These practices include drafting conventions to be used on the field of the drawings and instructions for the completion of the title blocks, revision blocks, and parts lists on the drawing formats.

2.2 SIGNATURES, APPROVALS, DATES, AND BLOCK ENTRIES

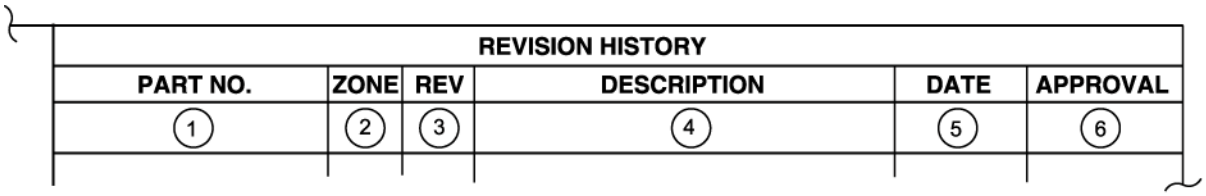
Unless otherwise specified by contract or order, signatures, approvals, dates, and block entries shall be made in the title and revision blocks of drawings as described in the following paragraphs.

2.2.1 CAD DRAWING. A CAD-prepared drawing shall be approved by signature or other approval indicator unique to the signer, capable of verification, and under the signer's sole control. After the approval and release of an original drawing or subsequent revision, the initial approval signatures shall not be required on previous revisions of the drawings. Original signatures or other approval indicators shall be required for a current revision only. The initials and names of those approving the original drawing and/or previous revisions shall be printed in place of the original signatures.

2.2.2 REVISION BLOCKS. Drawing revision blocks shall be completed by entering the required information in the revision block spaces in accordance with the following (see section IX for additional detailed requirements):

a. A- and B-Size Drawing Revision Blocks. Complete each A-size drawing revision block and each B-size drawing revision block or approved equivalent by entering the required information in each space as indicated in figure 2-1.

b. Revision Blocks on Drawings Larger Than B-Size. Complete each revision block on drawings larger than B-size (sizes C, D, E, F, and J) by entering the required information in each space as indicated in figure 2-2. The field of the drawing below the revision block shall be reserved for future revision data. A minimum of 90 millimeters (mm) (3.5 inches) of space shall be allocated for this purpose. No portion of the drawing or notes shall be placed in this space. See section III for KSC form numbers for these drawing formats.

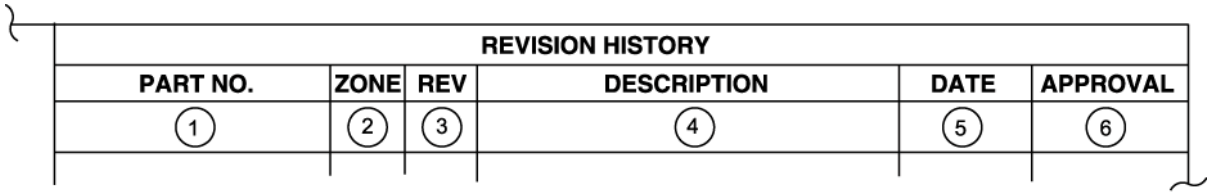


REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL
(1)	(2)	(3)	(4)	(5)	(6)

EACH SPACE IN THE REVISION BLOCK OF A-SIZE AND B-SIZE DRAWINGS SHALL BE COMPLETED AS INDICATED BELOW.

SPACE/TITLE		ENTRY DESCRIPTION
(1)	PART NO.	ENTER THE PART NUMBER TO WHICH THE DRAWING APPLIES, IF APPLICABLE.
(2)	ZONE	LEAVE BLANK.
(3)	REV	ENTER THE REVISION LETTER OF THE DRAWING REVISION (E.G., A, B, C, ETC.).
(4)	DESCRIPTION	ENTER A BRIEF DESCRIPTION OF THE CHANGES MADE BY THE REVISION, INCLUDING THE SHEET NUMBERS AND THE CHANGE ACTION APPLICABLE TO EACH SHEET (E.G., REVISION, ADDED, DELETED, REDRAWN, ETC.).
(5)	DATE	ENTER THE DATE OF THE REVISION (YY/MM/DD).
(6)	APPROVAL	ENTER THE SIGNATURE, INITIALS, NAME, OR APPROVAL INDICATOR OF THE RESPONSIBLE ENGINEER OR SUPERVISOR, AND THE MATERIALS AND PROCESSES ENGINEER AUTHORIZED TO APPROVE THE REVISION.

Figure 2-1. Revision Block Entries on A- and B-Size Drawings



REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL
(1)	(2)	(3)	(4)	(5)	(6)

EACH SPACE IN THE REVISION BLOCK OF DRAWINGS LARGER THAN B-SIZE SHALL BE COMPLETED AS INDICATED BELOW.

SPACE/TITLE		ENTRY DESCRIPTION
(1)	PART NO.	ENTER THE PART NUMBER TO WHICH THE DRAWING APPLIES, IF APPLICABLE.
(2)	ZONE	ENTER THE ZONE ON THE FIELD OF THE DRAWING AFFECTED BY THE REVISION.
(3)	REV	ENTER THE REVISION LETTER OF THE DRAWING REVISION (E.G., A, B, C, ETC.).
(4)	DESCRIPTION	ENTER A BRIEF DESCRIPTION OF THE CHANGES MADE BY THE REVISION, INCLUDING THE SHEET NUMBERS AND THE CHANGE ACTION APPLICABLE TO EACH SHEET (E.G., REVISION, ADDED, DELETED, REDRAWN, ETC.).
(5)	DATE	ENTER THE DATE OF THE REVISION (YY/MM/DD)
(6)	APPROVAL	ENTER THE SIGNATURE, INITIALS, NAME, OR APPROVAL INDICATOR OF THE RESPONSIBLE ENGINEER OR SUPERVISOR, AND THE MATERIALS AND PROCESSES ENGINEER AUTHORIZED TO APPROVE THE REVISION.

Figure 2-2. Revision Block Entries on Drawings Larger Than B-Size

2.2.3 TITLE BLOCKS. Drawing title blocks shall be completed by entering the required information in the title block space in accordance with the following:

a. Drawing Title Blocks. Complete each title block by entering the required information in each space in the date block as indicated in figure 2-3. Note that block locations are different on A-size formats.

b. Margin Number Block Entries on Drawings Larger Than A-Size. Complete each margin number block on drawings larger than A-size (sizes B, C, D, E, F, and J) by entering the required information in each space in the number block as indicated in figure 2-4.

c. Continuation Sheet Title Blocks. Complete the continuation sheet title blocks on the A-, B-, C-, D-, E-, and F-size drawings by entering the required information in each space of the title block as indicated in figure 2-5.

2.3 PARTS IDENTIFICATION/PARTS LIST

2.3.1 PARTS IDENTIFICATION. All parts shall be identified on the field of the drawing. Parts shall be identified by an item (find) number on the field of the drawing that is cross-referenced to the identifying part number appearing on the parts list. The parts list shall be an integral part of the drawing. Separate parts lists are not required. See section VI for additional parts identification requirements.

2.3.2 PARTS LIST. A typical parts list form used on a KSC aerospace or ground support equipment drawing is shown in figure 2-6. Each column on the format is identified, and a description of the entries to be made in each column is given. Additional parts list blocks or columns may be located to the left of and adjacent to the original title block or on a continuation sheet.

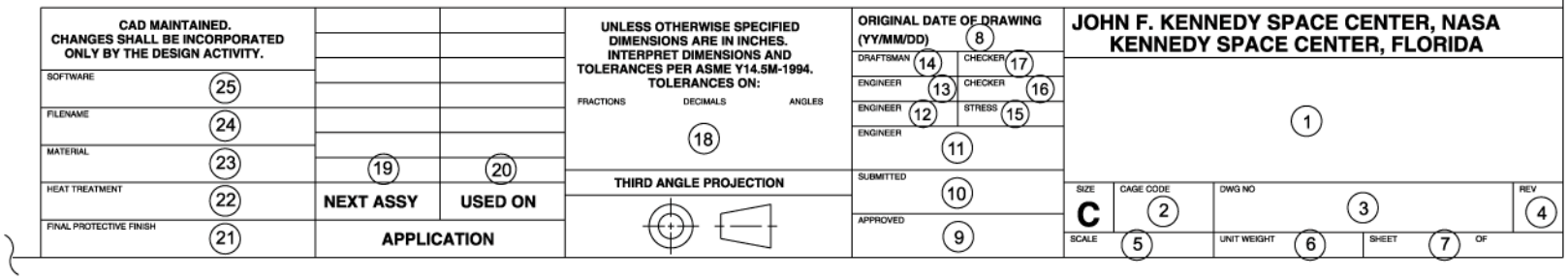
2.3.3 PARTS LIST USING SIMPLIFIED FORMATS. A simplified parts list format may be used as an alternative to the format shown in figure 2-6. Figure 2-7 shows a simplified format that may be used for procurement or for modification/installation purposes when there is no need for a hardware assembly or installation part number and no need to trace part changes except by revision. The format shown in figure 2-8 should be used if a part or quantity takeoff is to be performed by the fabricating, installing, or construction contractor.

2.4 DRAWING SCALE

All GSE drawings, except diagrams, schematics, perspectives, tabulations, and other similar drawings, should be drawn to scale.

2.4.1 SELECTION OF SCALE. When practicable, drawings should show an object or assembly at full-scale size. When it is not practicable to prepare the drawing at full scale, the drawing may be prepared to a reduced or enlarged scale. It is desirable, when practicable, that detail drawings be prepared to the same scale as pertinent assembly drawings.

2.4.2 INDICATION OF SCALE. The scale or scales to which drawings are prepared shall be indicated in the drawing scale block (see 2.2.3). The scale shall be indicated as a decimal or common fraction (e.g., 1.000, .375, 1/1, 3/8, etc.). The scales to which views, sections, or details are drawn shall be entered directly below the title of the view, section, or detail (e.g., SCALE: 1/2, .500). For scaling purposes, a graphic scale may be shown adjacent to the title block for each scale shown on the sheet.



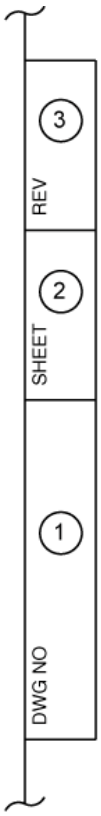
EACH SPACE IN THE TITLE BLOCK SHALL BE COMPLETED AS INDICATED BELOW. IF A SPACE IS NOT APPLICABLE, LEAVE BLANK.

SPACE/TITLE		ENTRY DESCRIPTION
1		ENTER THE TITLE OF THE DRAWING.
2	CODE	ENTER THE CAGE NUMBER (22264) FOR KSC.
3	DWG NO	ENTER THE DRAWING NUMBER (E.G., 79K07050).
4	REV	ENTER THE REVISIONS LETTER OF THE DRAWING REVISION (E.G., A, B, C, ETC.).
5	SCALE	ENTER THE SCALE OF THE DRAWING OR ENTER "AS NOTED."
6	UNIT WEIGHT	ENTER THE UNIT WEIGHT OF THE ITEM SHOWN ON THE DRAWING.
7	SHEET OF	ENTER THE SHEET NUMBER ON EACH SHEET (E.G., SHEET 2 OF). FOR MULTISHEET DRAWINGS, THE TOTAL NUMBER OF SHEETS IN THE DRAWING SHALL BE ENTERED ON THE FIRST AND LAST SHEETS OF THE DRAWING ONLY (E.G., SHEET 1 OF 10. SHEET 10 OF 10). (ALPHANUMERIC SHEET NUMBERS AS DESCRIBED IN 9.6 SHOULD BE AVOIDED FOR INITIAL RELEASES.)
8	ORIGINAL DATE OF DRAWING	ENTER THE DATE OF THE ORIGINAL DRAWING (AS DEFINED IN 1.5).
9	APPROVED	ENTER THE SIGNATURE, NAME, OR APPROVAL INDICATOR OF THE RESPONSIBLE SUPERVISOR OR MANAGER AUTHORIZED TO APPROVE THE DRAWING.
10	SUBMITTED	ENTER THE SIGNATURE, NAME OR APPROVAL INDICATOR OF THE ENGINEER SUBMITTING THE DRAWING FOR APPROVAL.

Figure 2-3. Title Block Entries on Aerospace and Ground Support Equipment Drawings (Sheet 1 of 2)

SPACE/TITLE		ENTRY/DESCRIPTION
11	ENGINEER	ENTER THE NAME OF THE DESIGN ENGINEER.
12	ENGINEER	ENTER THE NAME OR INITIALS OF THE MATERIALS AND PROCESSES ENGINEER AUTHORIZED TO APPROVE THE DRAWING.
13	ENGINEER	ENTER THE NAME OR INITIALS OF ANY ADDITIONAL ENGINEER.
14	DRAFTSMAN	ENTER THE NAME OR INITIALS OF THE DRAFTSMAN.
15	STRESS	ENTER THE NAME OR INITIALS OF THE STRESS ENGINEER.
16	CHECKER	ENTER THE NAME OF INITIALS OF THE CHECKER.
17	CHECKER	ENTER THE NAME OR INITIALS OF OTHER CHECKER.
18	TOLERANCES ON FRACTIONS DECIMALS ANGLES	ENTER THE APPLICABLE TOLERANCES ON DECIMALS, FRACTIONS, AND ANGLES (E.G., X.XX ± 0.03, ±1/32, ±1°).
19	NEXT ASSY	ENTER THE NEXT HIGHER ASSEMBLY DRAWING NUMBER.
20	USED ON	ENTER THE NAME OF THE PROGRAM OR HARDWARE FOR WHICH THE DRAWING IS USED (E.G., SHUTTLE, KSC, KSC GSE).
21	FINAL PROTECTIVE FINISH	ENTER THE APPLICABLE FINAL PROTECTIVE FINISH AND SPECIFICATION.
22	HEAT TREATMENT	ENTER THE APPLICABLE HEAT TREATMENT REQUIREMENT AND SPECIFICATION.
23	MATERIAL	ENTER THE APPLICABLE MATERIAL SPECIFICATION.
24	FILE NAME	ENTER THE APPLICABLE CAD FILENAME.
25	SOFTWARE	ENTER THE APPLICABLE CAD SOFTWARE USED.

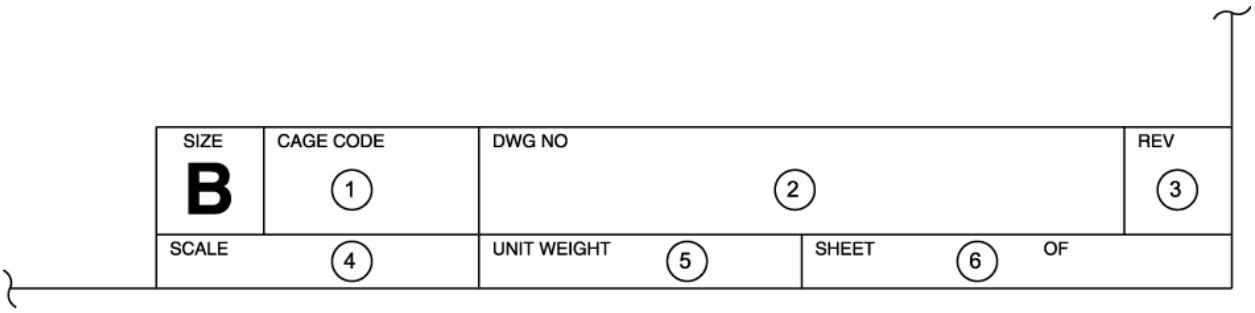
Figure 2-3. Title Block Entries on Aerospace and Ground Support Equipment Drawings (Sheet 2 of 2)



EACH SPACE IN THE MARGIN NUMBER BLOCK SHALL BE COMPLETED AS INDICATED BELOW.

	SPACE/TITLE	ENTRY DESCRIPTION
(1)	DWG NO	ENTER THE DRAWING NUMBER NUMBER (E.G., 79K07051).
(2)	SHEET	ENTER THE SHEET NUMBER.
(3)	REV	ENTER THE REVISION LETTER OF THE DRAWING REVISION (E.G., A, B, C, ETC.).

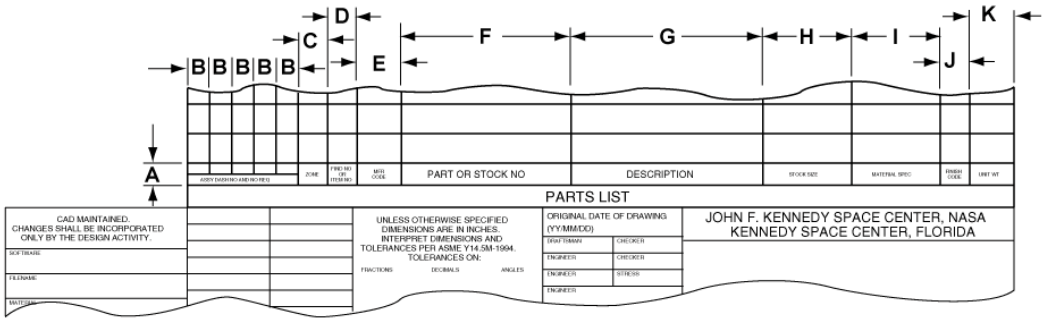
Figure 2-4. Margin Number Block Entries on Drawings Larger Than A-Size



EACH SPACE IN THE TITLE BLOCK OF A DRAWINGS CONTINUATION SHEET LARGER THAN A-SIZE SHALL BE COMPLETED AS INDICATED BELOW.

SPACE/TITLE		ENTRY DESCRIPTION
1	CAGE NO.	ENTER THE KSC CAGE CODE NUMBER (22264).
2	DWG NO.	ENTER THE DRAWING NUMBER (E.G., 79K12345).
3	REV	ENTER THE REVISION LETTER OF THE DRAWING REVISION (E.G., A).
4	SCALE	ENTER THE SCALE OF THE DRAWING OR ENTER "AS NOTED."
5	UNIT WEIGHT	ENTER THE UNIT WEIGHT.
6	SHEET	ENTER THE SHEET NUMBER ON EACH SHEET (E.G., 2, 3, ETC.). ON THE LAST SHEET ONLY, ENTER THE NUMBER OF THE LAST SHEET AND THE TOTAL NUMBER OF SHEETS IN THE DRAWING (E.G., 5 OF 5). (ALPHANUMBERIC SHEET NUMBERS AS DESCRIBED IN 9.6 SHOULD BE AVOIDED FOR INITIAL RELEASES.)

Figure 2-5. Title Block Entries on Drawing Continuation Sheets



THE PARTS LIST ON A KSC DRAWING SHALL BE COMPLETED BY ENTERING THE REQUIRED INFORMATION IN EACH COLUMN IN ACCORDANCE WITH THE FOLLOWING.

LINE/ COLUMN	TITLE	ENTRY DESCRIPTION
A	ASSY DASH NO.	ENTER THE ASSEMBLY OR SUBASSEMBLY DASH NUMBER (E.G., -1, -3, -4, ETC.).
B	NUMBER REQUIRED	ENTER THE TOTAL QUANTITY OF EACH ITEM REQUIRED TO COMPLETE ONE ASSEMBLY OR SYSTEM. THE QUANTITY OF THE LINE DESCRIBING THE MAIN ASSEMBLY (-1) SHALL CONTAIN A DASH (-) ONLY.
C	ZONE	MAY BE USED TO LOCATE THE ITEM ON THE FIELD OF THE DRAWING. ENTER ZONE AND SHEET NUMBER AS SHOWN FOR CALLOUTS (SEE 2.22).
D	FIND OR ITEM NO.	ENTER NUMBERS BEGINNING WITH THE FIRST ITEM OR COMPONENT LISTED IN CONSECUTIVE ORDER (I.E., 1, 2, 3, ETC.). A FIND NUMBER IS NOT REQUIRED FOR THE TOP LEVEL ASSEMBLY.
E	MFR CODE	WHEN NASA PART NUMBERS HAVE NOT BEEN ASSIGNED TO AN ITEM, THE PARTS LIST SHALL INCLUDE ALL THE REQUIRED PROCUREMENT INFORMATION SUCH AS MANUFACTURER'S NAME, ADDRESS, AND PART IDENTIFICATION NUMBER. THE MANUFACTURER SHALL BE IDENTIFIED BY A CODE IDENTIFICATION NUMBER ENTERED IN THIS COLUMN. IF THE MANUFACTURER HAS NOT BEEN ASSIGNED A CODE IDENTIFICATION NUMBER, ENTER A NOTE FLAG (▷) IN THIS COLUMN WITH THE APPROPRIATE INFORMATION DISPLAYED IN THE ACCOMPANYING NOTE. GOVERNMENT OR INDUSTRY STANDARD PART NUMBERS [E.G., ARMY/NAVY (AN), AIR FORCE/NAVY (AN), MILITARY STANDARD (MS), ETC.] DO NOT REQUIRE CODE IDENTIFICATION NUMBERS.
F	PART, STOCK, OR DRAWING NO.	ENTER THE IDENTIFYING NUMBER FOR EACH ENTRY ON THE PARTS LIST (E.G., DRAWING AND DASH NUMBER, GOVERNMENT OR INDUSTRY STANDARD AND DASH NUMBER, COMPLETE CATALOG NUMBER OF VENDOR PART, ETC.).
G	DESCRIPTION	ENTER THE NOUN OR NOUN PHRASE APPLICABLE TO EACH ITEM. IN CASES WHERE ITEMS ARE DETAILED ON THE ASSEMBLY, THE TOP LINE IN THIS COLUMN SHALL DEFINE THE NAME OF THE ITEM (E.G., COVER, PLATE, BRACE, ETC.) AND THE SECOND LINE SHALL INDICATE THE NOMENCLATURE MODIFIERS.
H	STOCK SIZE	ENTER THE SIZE AND SHAPE OF MATERIAL WHERE APPLICABLE (E.G., 10 GA., 2-314 O.D. X 5/32,70 O.D. X 4, ETC.).
I	MATERIAL SPECIFICATION	ENTER THE GOVERNMENT OR NASA SPECIFICATION FOR MATERIALS LISTED IN COLUMNS F AND G. FOR MATERIALS COMMON TO SEVERAL ITEMS OR WHERE THERE IS INSUFFICIENT ROOM WITHIN THE COLUMN, A NOTE FLAG AND NOTE MAY BE USED.
J	FINISH CODE	ENTER A MATERIAL FINISH CODE NUMBER (E.G., 1, 2, ETC.) REFERENCED BY A SPECIFIC NOTE.
K	UNIT WT	THE UNIT WEIGHT OF PARTS OR ASSEMBLIES MAY BE ENTERED IN THIS COLUMN.

Figure 2-6. Parts List Format for Aerospace and Ground Support Equipment Drawings

ITEM NO.	QUANTITY	DESCRIPTION	MATL/PART NO.

FLAG NOTE WHEN USED

THIS SIMPLIFIED PARTS LIST MAY BE USED FOR PROCUREMENT OR MODIFICATION/INSTALLATION DRAWINGS REQUIRING NO HARDWARE ASSEMBLY, INSTALLATION PART NUMBERS, OR TRACING OF PART CHANGES. WHEN THIS FORMAT IS USED, IT SHALL BE COMPLETED AS FOLLOWS:

BLOCK TITLE	ENTRY DESCRIPTION
ITEM NO.	BEGINNING WITH THE NUMBER 1, ENTER NUMBERS CONSECUTIVELY FOR THE ITEMS OR PARTS (E.G., 1, 2, 3, ETC). A FIND NUMBER IS NOT REQUIRED FOR THE TOP LEVEL ASSEMBLY.
QUANTITY	ENTER THE TOTAL NUMBER OF EACH ITEM REQUIRED TO COMPLETE THE HARDWARE, SYSTEM OR MODIFICATION PROJECT.
DESCRIPTION	ENTER A COMPLETE DESCRIPTION OF THE ITEM, INCLUDING SIZE OR SHAPE (E.G., ANGLE 1 X 1 X 1/8. 25 X 25 X 3, TUBING 1 X 0.0951).
MATL/PART NO.	ENTER THE MATERIAL SPECIFICATION OR PART NUMBER. A FLAG NOTE MAY BE USED TO PROVIDE THE MANUFACTURER'S NAME, COMMERCIAL AND GOVERNMENT ENTITY (CAGE) NUMBER, OR SPECIAL NOTES FOR FABRICATION, ASSEMBLY, OR INSTALLATION.

Figure 2-7. Simplified Parts List Format

ITEM NO.	DESCRIPTION	MATL/PART NO.

FLAG NOTE WHEN USED

THIS FORMAT SHALL BE USED FOR A SIMPLIFIED PARTS LIST WHEN A PART OR QUANTITY TAKEOFF IS TO BE PERFORMED BY THE FABRICATING, INSTALLING, OR CONSTRUCTION CONTRACTOR. WHEN THIS FORMAT IS USED, IT SHALL BE COMPLETED AS FOLLOWS:

BLOCK TITLE	ENTRY DESCRIPTION
ITEM NO.	BEGINNING WITH THE NUMBER 1, ENTER NUMBERS CONSECUTIVELY FOR THE ITEMS OR PARTS (E.G., 1, 2, 3, ETC.). A FIND NUMBER IS NOT REQUIRED FOR THE TOP LEVEL ASSEMBLY.
DESCRIPTION	ENTER A COMPLETE DESCRIPTION OF THE ITEM, INCLUDING SIZE OR SHAPE (E.G., ANGLE 1 X 1 X 118.25 X 25 X 3. TUBING 1 X 0.0951).
MATL/PART NO.	ENTER THE MATERIAL SPECIFICATION OR PART NUMBER. A FLAG NOTE MAY BE USED TO PROVIDE THE MANUFACTURER'S NAME, CAGE NUMBER, OR SPECIAL NOTES FOR FABRICATION, ASSEMBLY, OR INSTALLATION.

Figure 2-8. Simplified Parts List Format for Use When Parts or Quantity Takeoff Is To Be Performed by the Contractor

2.4.3 DECIMAL SCALE. The decimal method of indicating the scale expresses the size of the object as drawn relative to its full size.

For example:	Full size	1.000 or FULL
	Enlarged	10.000, 4.000, 2.000
	Reduced	.100, .250, .500

2.4.4 COMMON FRACTION SCALE. The common fraction method of indicating the scale expresses, in the form of a common fraction, the ratio of the size of the object as drawn relative to its full size.

For example:	Full size	1/1 or FULL
	Enlarged	10/1, 4/1, 2/1
	Reduced	1/2, 1/4, 1/8, 1/10

2.4.5 NOT TO SCALE. For drawings not prepared to any scale, the word NONE shall be entered after SCALE in the space provided on the drawing format. When an individual not-to-scale dimension is used within a view, section, or detail, it shall be noted by the use of the abbreviation NTS after the dimension callouts. When a view, section, or detail contains all not-to-scale dimensions, SCALE: NONE shall be entered directly below the title of the view, section, or detail.

2.5 CALLOUTS ON DRAWINGS

2.5.1 ITEM (FIND) NUMBERS. Item (find) numbers cross-referenced to the item number in the parts list shall appear on the field of drawing as shown in figure 2-9. The item number shall be 3 millimeters (mm) (1/8 inch) high within a 10-mm- (3/8-inch-) diameter circle. On drawings such as Cable Interconnect Diagrams, Wiring Diagrams, Schematics, or Rack Elevations, the item number may be enclosed in a small box 6 mm (1/4 inch) high by 12 mm (1/2 inch) minimum length. (See figure 4-3 as example.) The draftsman shall make a reasonable effort to align the item numbers in an orderly arrangement (numbers need not run consecutively) to aid in the readability of the drawing. Assembly information may be noted either on the field of the drawing or by a flag (▷) to a drawing note as shown in figure 2-9; however, none of the information tabulated in the list of material shall be repeated beside the item find number. See section VI for additional requirements.

2.5.2 MECHANICAL FIND NUMBERS AND REFERENCE DESIGNATORS. Assigned mechanical system find numbers and electrical reference designators shall be used for all schematic components and end connections. The mechanical find numbers and electrical reference designators refer to the function of the component in the system and are used for one particular part only. The mechanical find numbers and electrical reference designators shall be assigned by the KSC design organization from an allotment of mechanical find numbers and electrical reference designators obtained from the appropriate documentation center. See section VI for detailed requirements.

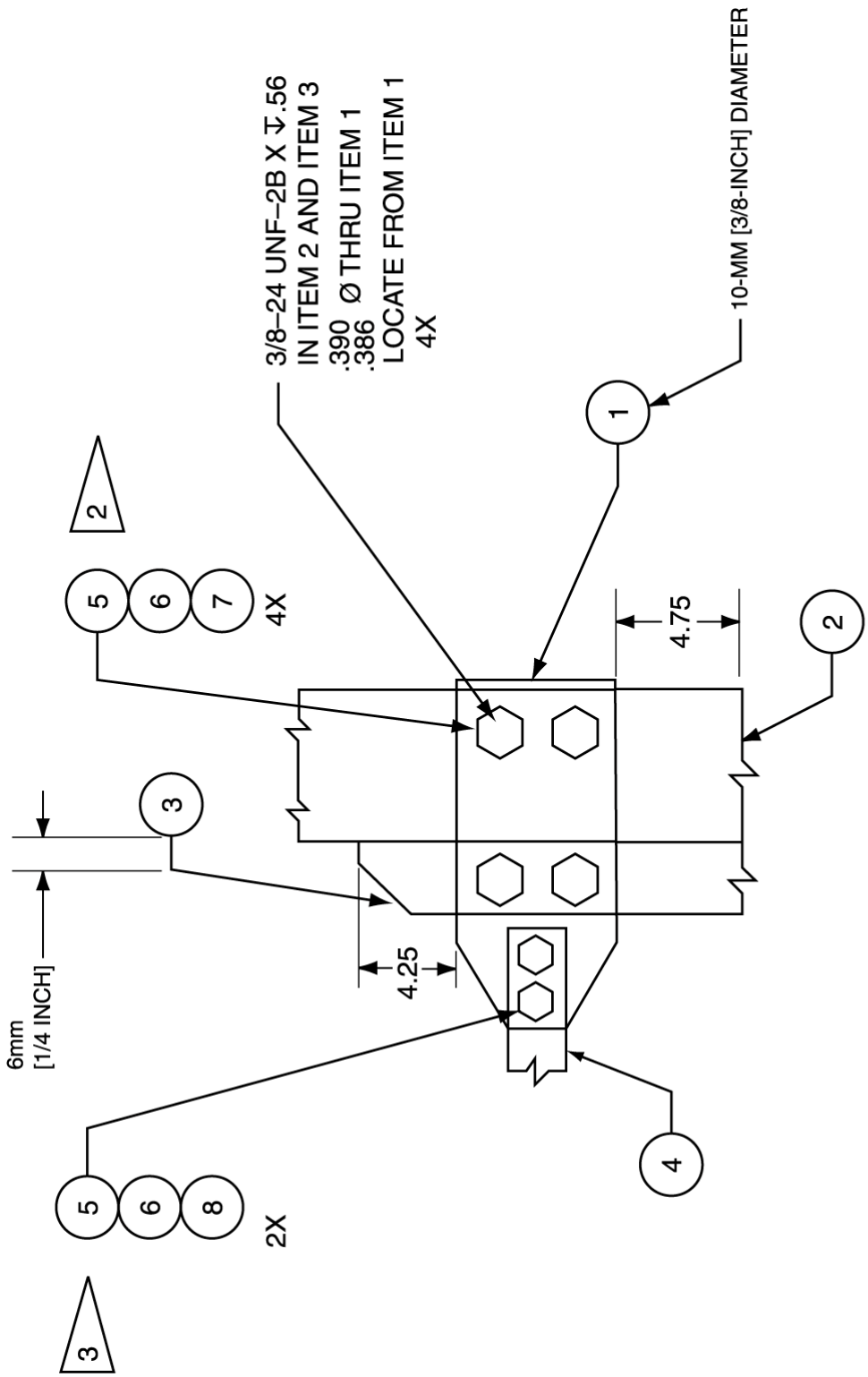


Figure 2-9. Typical Example of Item (Find) Numbers

2.6 WEIGHT OF COMPONENTS

The weight of the assembly or detail part shall be entered on the drawing in the appropriate place in the title block when necessary.

2.7 DIMENSIONING AND TOLERANCING

American Society of Mechanical Engineers (ASME) Y14.5M describes permissible dimensioning and tolerancing variations (both metric and U.S. Customary) in respect to factory-oriented machined and sheet metal parts and may be utilized in its entirety to illustrate permissible variations as described, or a drawing may definitely state (by dimensions, form tolerances, or notes) those portions of AMSE Y14.5M that are applicable. In either case, the draftsman, designer, and engineer must be completely familiar with the contents of ASME Y14.5M in order to evaluate its required usage and effect. Additional specifications on dimensioning and tolerancing of metric products are described in ASME B4.3.

When referenced by drawing note, ASME Y14.5M defines the variations permissible unless modified (either smaller or greater tolerances) by drawing dimensions, form tolerances, etc., and is an effective means of establishing control and interpretation of implied tolerances (squareness, flatness, etc.). Knurl dimensioning shall be in accordance with ASME B94.6. Metric limits and fits of holes and shafts shall be in accordance with ASME B4.2.

2.8 DUAL DIMENSIONING

Dual dimensioning is a procedure for showing values from two different measurement systems [e.g., International System of Units (SI) or metric system, and the U.S. Customary Units] on the same drawing. Dual dimensions shall not be used on metric projects except to describe interfaces with nonmetric items as authorized by the responsible design organization. The method used to dual-dimension a drawing shall be either the position method or the bracket method. With the position method (figure 2-10), the value in the primary measurement units (primary value) is separated by a line from the value in the secondary measurement units (secondary value). With the bracket method (figure 2-11), the primary value is followed by the secondary value in brackets. When either method is used, a drawing note shall be provided explaining how the primary and secondary dimensions are identified (e.g., DIMENSIONS IN [ ] ARE IN INCHES).

2.9 METRIC VALUES

Metric values, when used on GSE drawings, shall be in accordance with ASTM SI 10.

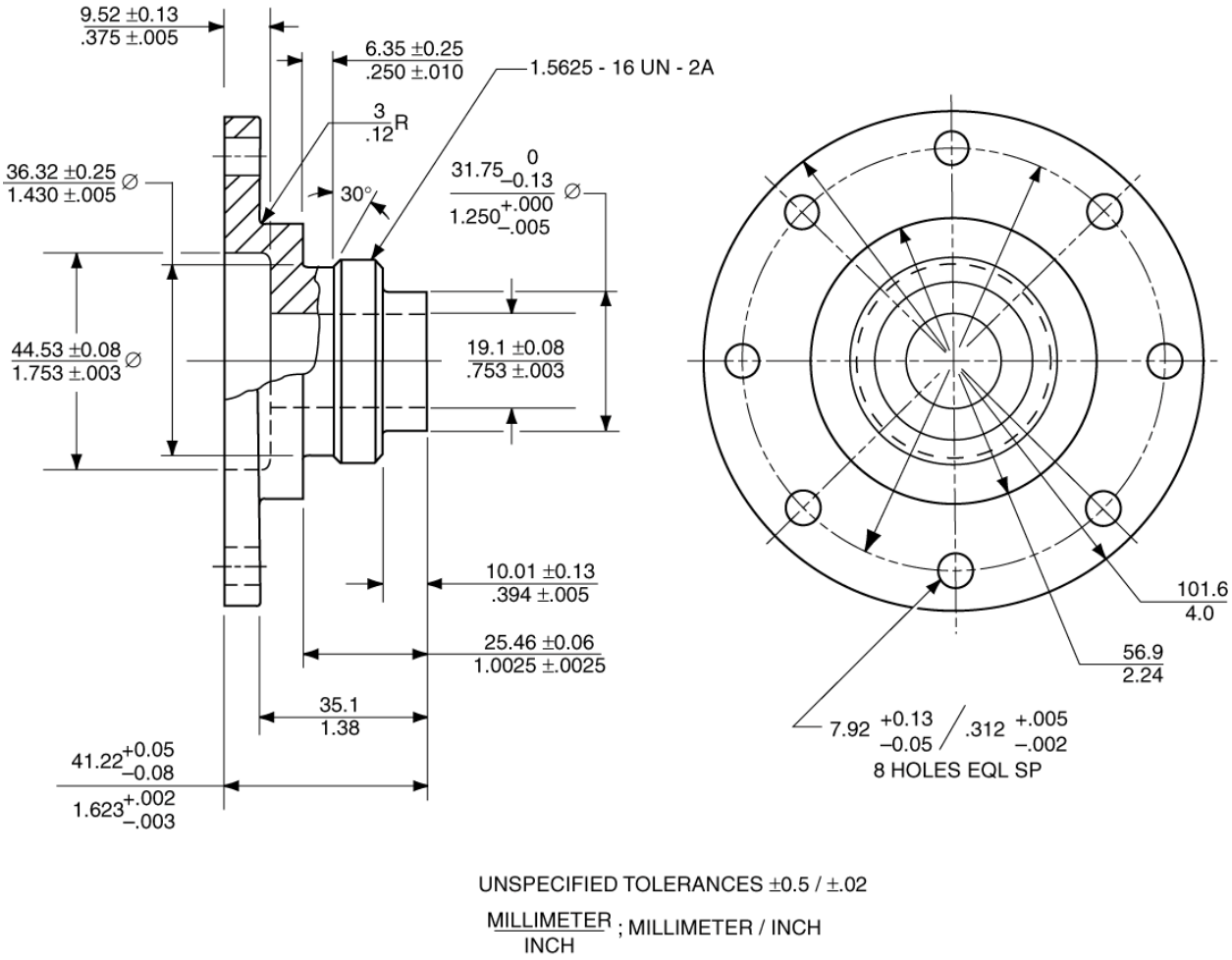


Figure 2-10. Position Method

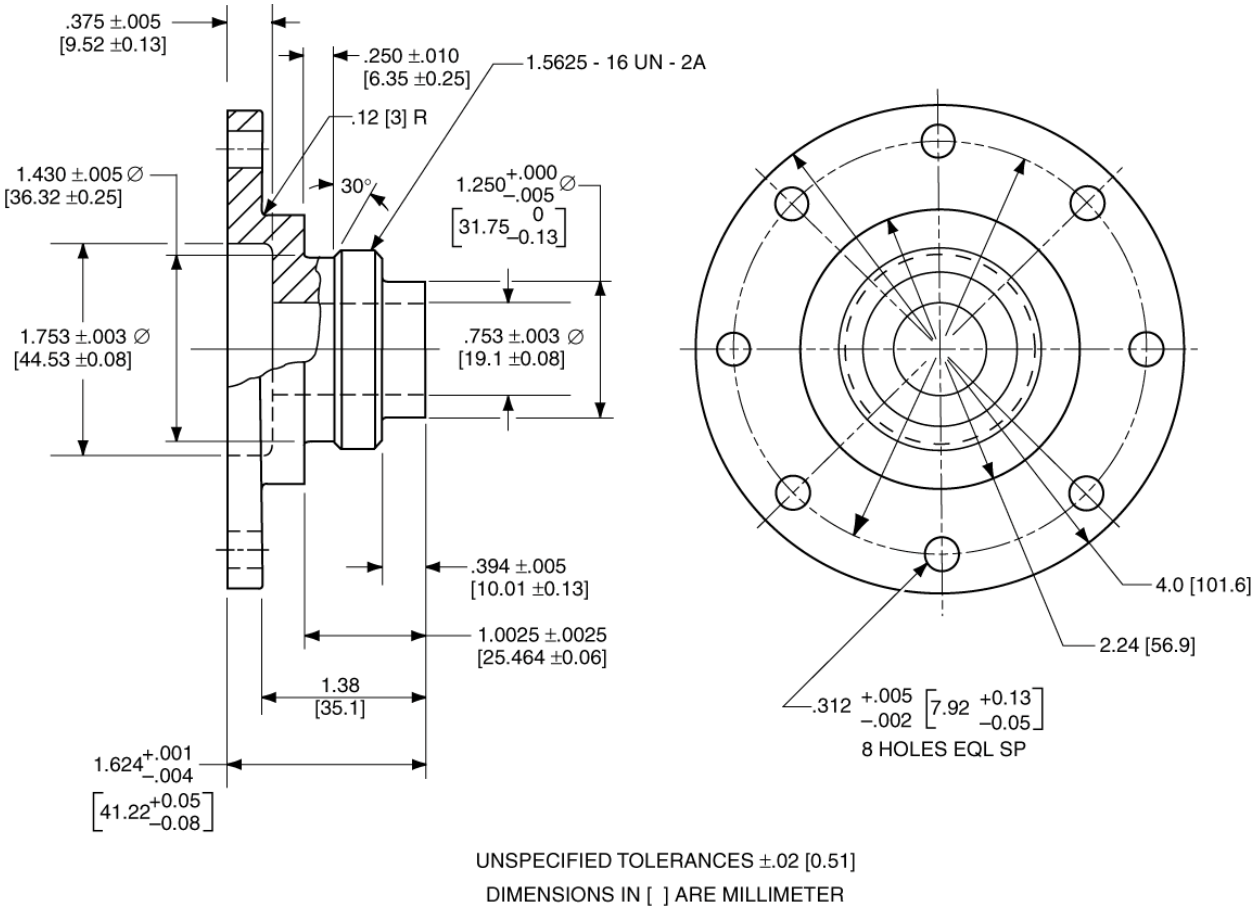


Figure 2-11. Bracket Method

2.10 SCREW THREADS

Screw threads shall be represented in accordance with ASME Y14.6 and ASME Y14.6AM.

2.11 MECHANICAL SPRINGS

Mechanical springs shall be represented in accordance with ASME Y14.13M.

2.12 GEARS

Gears shall be specified on drawings in accordance with ASME Y14.7.1 and ASME Y14.7.2.

2.13 FORGINGS

Forgings shall be specified in accordance with ASME Y14.8M.

2.14 OPTICAL ELEMENTS AND OPTICAL SYSTEMS

Optical elements and optical systems shall be delineated in accordance with ASME Y14.18M.

2.15 WELDING PRACTICES

Welding practices shall be in accordance with the terms and definitions specified in American National Standard Institute/American Welding Society (ANSI/AWS) A3.0. Nondestructive testing and welding symbols shall be in accordance with ANSI/AWS A2.4.

2.16 ABBREVIATIONS

Abbreviations may be used on drawings to conserve space when their meaning is clear. Little-known abbreviations shall be explained on the drawing. When abbreviations are used, they shall conform to ASME Y14.38. Acronyms and abbreviations commonly used at KSC are contained in NASA TM-103575, which shall also be used for defining acronyms and abbreviations.

2.17 GRAPHIC SYMBOLS

Graphic symbols used on GSE drawings shall be in accordance with KSC-STD-152-2.

2.18 SURFACE TEXTURE

Surface texture or roughness, waviness, and lay on drawings shall be indicated in accordance with ASME B46.1. Surface texture symbols shall be in accordance with ASME Y14.36M. Unless otherwise specified, the finish symbol ($\surd$) preceded by the roughness value (e.g., $\overset{32}{\surd}$) shall indicate the maximum allowable surface roughness produced by a machining operation. (See figure 2-12.)

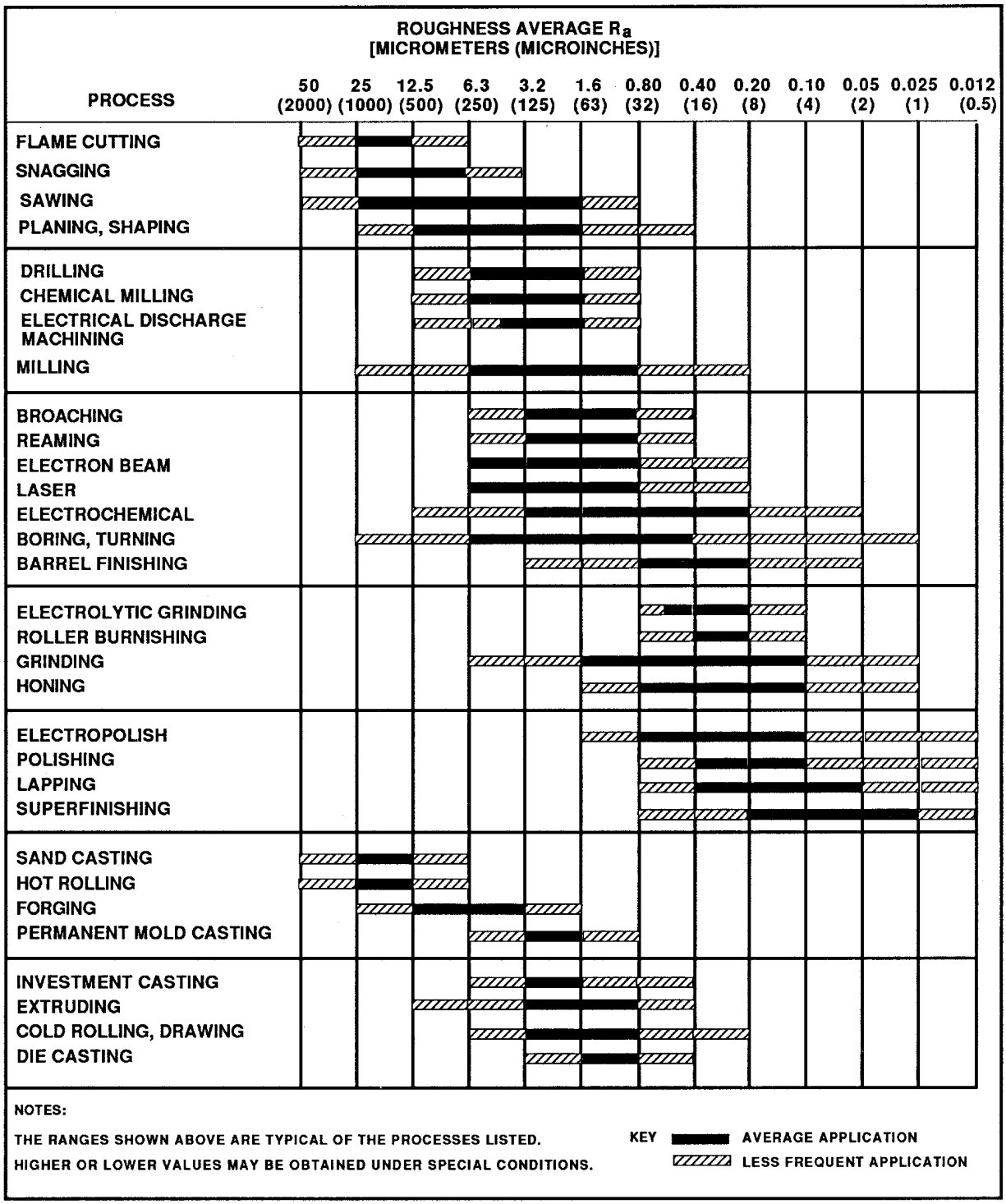


Figure 2-12. Surface Roughness Produced by Common Production Methods

When a surface is produced by other methods such as casting, forging, punching, molding, etc., the method shall be indicated by a note adjacent to the symbol (e.g., 250 AS CAST, 125 AS PUNCHED, AS ROLLED, etc.).

A finish symbol with the roughness value ($^{XX}\checkmark$) shown on a part produced by casting, forging, etc., shall indicate the allowance required to attain the machined surface finish on the drawing. In general, the finish symbol with the roughness value shall be shown only on the view where the controlling dimension is located and omitted from all other views. However, when a machined surface appears in several views on a large drawing (sizes E or F), the finish symbol without the roughness value may be shown in the different views or sections. When using multiple sheet drawings, the finish symbol shall be placed near the controlling dimension and the symbol shall be placed on all the machined surfaces shown on each sheet.

A delineation should specify any surfaces of a machined part that are a different roughness from the majority of parts. If all the parts have the same surface, the finish symbol with the roughness value shall be used unless otherwise specified.

2.19 COMPUTER-AIDED DESIGN (CAD) DRAWINGS

The use of CAD systems in preparing drawings is preferred. CAD drawings must meet the requirements for legibility and reproducibility specified in this document, and the system used must provide the following capabilities:

a. Capability to generate full-size drawings.

b. Capability to prepare drawings on material as specified in 3.8 and/or 3.9 and to print the drawings on the front side of the formats.

c. Capability to produce full-size drawings that are capable of being manually revised.

d. Capability to produce drawings that meet the microfilming requirements specified in this document.

e. Capability of being converted in accordance with the Initial Graphics Exchange Specification (IGES) software or drawing interchange file (DXF) software format.

2.20 CAD LINE VARIANCE

Line conventions may vary for CAD-prepared drawings as follows:

a. All lines and letters on originals may be applied using ink.

b. All lines may be the same width if microfilm requirements are met. It is preferred that lines for the outline and features of the item shown on a drawing be wider than dimension lines.

2.21 MULTIVIEWS AND SECTIONAL VIEWS

Multiviews and sectional views shown on drawings shall be in accordance with ASME Y14.3M. Isometric, pictorial, or other views may be shown on the drawings provided there is some particular advantage and clarity is not degraded.

2.22 SECTION, DETAIL, AND VIEW IDENTIFICATION

The preferred method of identifying sections, views, and details is described in the following paragraphs. Alternatively, the method shown in Volume II, paragraph 2.19 may be used.

Identification of sections, details, and views shall be assigned in alphabetical sequence. In cases where the single alphabet is exhausted, multiple letters may be used (e.g., AA, AB, etc.). The letters I, O, Q, S, X, and Z shall not be used. In no case shall a section, view, or detail of the same drawing carry the same identifying letter (e.g., if section A exists, there shall be no view A or detail A). Identifying letters shall be 5-mm (3/16-inch) uppercase Gothic letters with the description in 5-mm (3/16-inch) uppercase Gothic letters as shown in figures 2-13 and 2-14.

The section, detail, and view identification letters shall be displayed as shown in figure 2-13. The sheet number and zone for the location of the section, view, or detail shall be displayed in a location symbol (see figure 2-15); a dash line in the lower half indicates that the location is on the same page.

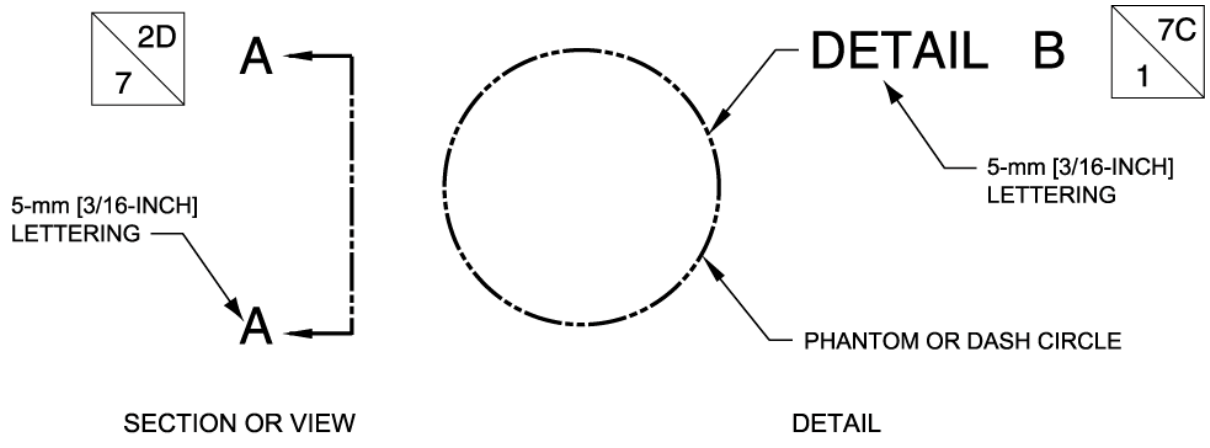


Figure 2-13. Section, Detail, or View Callouts

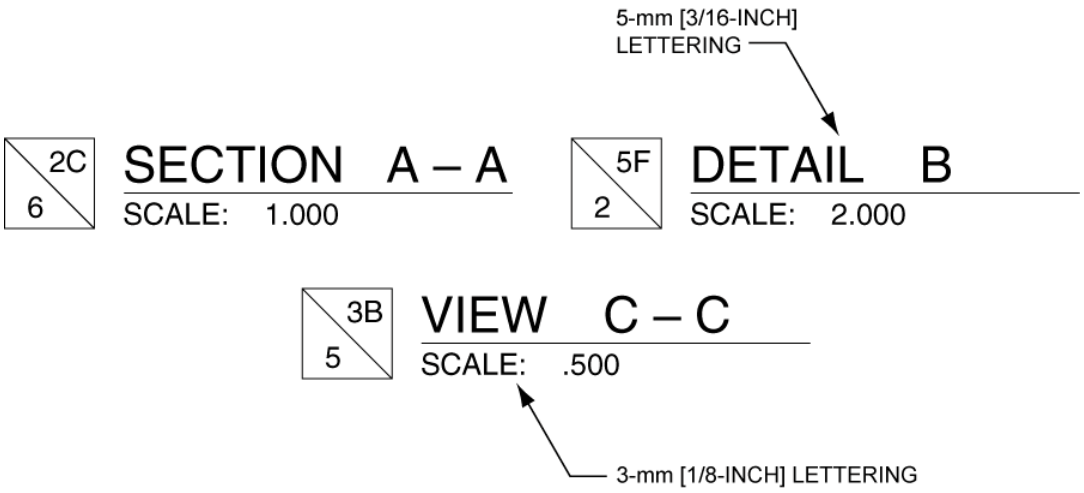


Figure 2-14. Section, Detail, or View Identification

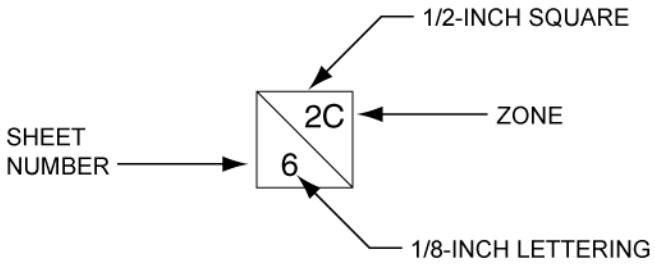


Figure 2-15. Location Symbol

Identification letters and numbers of sections, details, or views shall be the same identification letters and numbers as the corresponding callouts (figure 2-14). The lower location symbol shall display the sheet number and zone from which the section, detail, or view is taken.

If the same section, detail, or view is used on multiple sheets, the same identifying letter shall be used. An example is shown in figure 2-16.

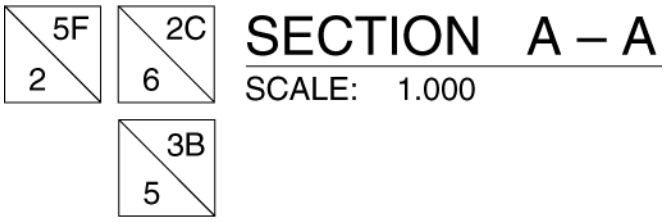


Figure 2-16. Example of Callouts of a Section, Detail, or View Used in Multiple Places

Drawings shall cross-reference a view, section, or detail and the portion of the drawing that it clarifies by the use of a diagonally divided square block as shown in figure 2.15. Size of block should be uniform within the same drawing.

2.23 CONTINUATION SYMBOL

This symbol may be used whenever it is necessary to continue a line from one sheet of the drawing to another or to continue lines on the same sheet when the drawing field is too congested. Its application is primarily for schematics (electrical or mechanical), block diagrams, and cable interconnect diagrams, but it may also apply to other drawings where a single line needs to match or continue to another sheet.

The symbol shall consist of a 13-mm-(1/2-inch-) diameter ballout split in half horizontally and positioned at the end of the line to be continued. The top half of the ballout is the circuit or line identifier. These identifiers shall be assigned consecutively throughout the drawing package beginning with number 1. The last ballout number used should be entered in the general notes at the front of the package. In cases where the line is continued on the same sheet, letters shall be used in place of numbers. Beginning with the letter A, consecutive letters shall be assigned to only those lines confined on the same sheet.

The lower half of the ballout is used to identify the sheet to which the line continues. When the line continues on the same sheet, a short solid line shall be inserted in the lower half.

An example of a continuation symbol is shown in figure 2-17.

NOTE

Numbers or letters shall be 3-mm-(1/8-inch-) high characters.

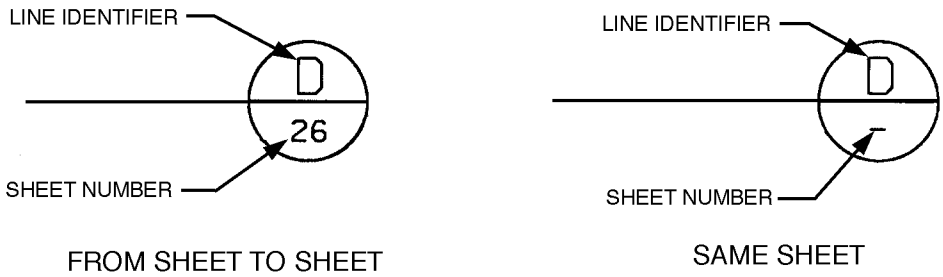


Figure 2-17. Continuation Symbol

2.24 IDENTIFICATION MARKING

2.24.1 MARKING REQUIREMENTS. Requirements and methods for marking of GSE shall be in accordance with KSC-STD-E-0015.

2.24.2 DRAWING REQUIREMENTS. When an item requires identification marking, its drawing shall specify the exact marking requirements. Those requirements shall define the method and contents of the marking. For markings to be applied by rubber stamp, stencil, silk screening, and other similar processes, the material to be used in marking and any protective coatings shall also be specified. The identifying number shall be the part number of the item as shown on the drawing. Examples of requirements to be specified on drawings are as follows:

> ITEM IDENTIFICATION: INK STAMP OR STENCIL THE FOLLOWING MARKINGS WITH BLACK INK A-A-56032 IN 3-MILLIMETER- (1/8-INCH-) HIGH GOTHIC CHARACTERS (e.g., 79K12345-6).
>
> ITEM IDENTIFICATION: DIE STAMP THE FOLLOWING MARKINGS IN 5-MILLIMETER- (3/16-INCH-) HIGH GOTHIC CHARACTERS (e.g, 79K12345-17). FILL LETTERING WITH WHITE INK A-A-208.

2.24.2.1 Location and Size. The location and size of the identification marking shall be specified on the depiction of the item if it must be controlled due to function/fit requirements or subsequent finish application. The location shall be identified by a leader pointing to the surface or by dimensionally locating marking rectangle. (See figure 2-18.)

2.24.2.2 Assembly Marking. Requirements for identification marking of assemblies shall be specified on the assembly drawing. Assemblies shall use identification plates where practical. Identification plates shall be in accordance with 75M50393 or equal. Identification plates shall be selected based on application, space available, and data required. Location shall be specified on the drawing. An example of requirements to be specified on the drawing is as follows:

> 2 ITEM IDENTIFICATION: DIE STAMP 75M50393-2 I.D. PLATE WITH 5-MILLIMETER- (3/16-INCH-) HIGH LETTERS.

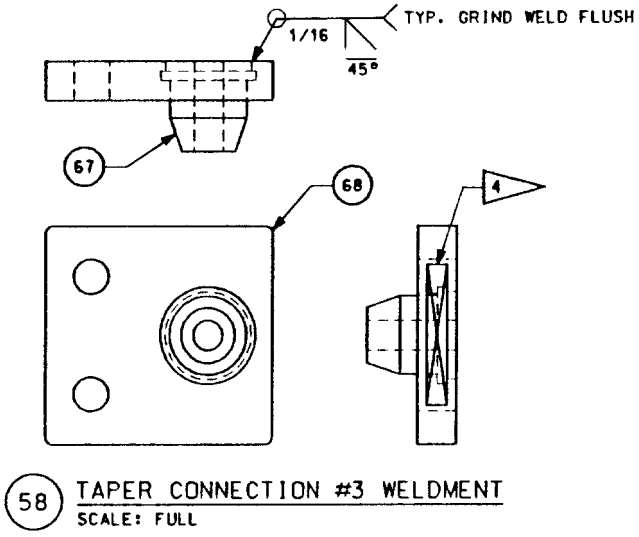


Figure 2-18. Identification Location

2.25 LEGIBILITY AND REPRODUCIBILITY

All lines and lettering on GSE drawings shall be of such quality and size as to remain clear and legible when the drawing is reduced to one-half its original size. On drafting film, ink or plastic lead shall be used for drawings. Graphite-based drawing lead shall not be used on KSC drawings. Guidelines for preparation of lines and lettering are given in ASME Y14.2M and the following paragraphs.

2.25.1 LINES.

2.25.1.1 Line Quality. Lines that are very thin or are not uniformly opaque on the original drawing become ragged in a print made from microfilm, and wider or denser portions of lines may increase in width while thinner or less dense portions may disappear completely. Therefore, all lines on a drawing shall be uniformly opaque.

2.25.1.2 Line Width. Since all lines must be uniformly opaque, any desired contrast between object lines and other lines can be obtained only by a variance in the relative width of lines. Relative widths for standard types of lines are shown in figure 2-19.

2.25.1.3 Line Spacing. Lines spaced close together (crosshatching, etc.) have a tendency to flow together on successive generations of microfilm reproductions. For this reason, a minimum spacing of 1.5 mm (0.06 inch) between lines shall be maintained.

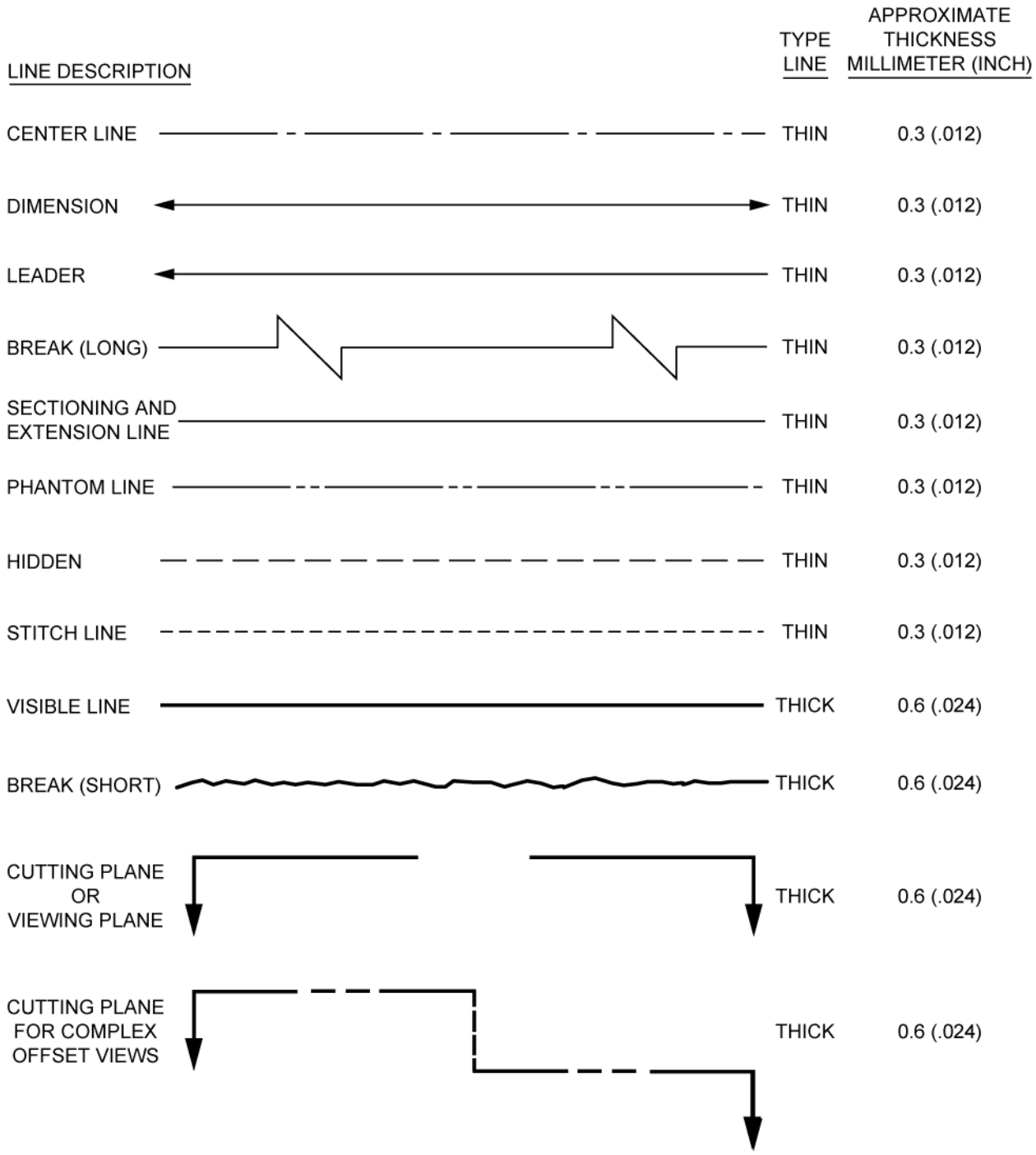


Figure 2-19. Line Standards

2.25.2 LETTERING. Lettering size, including hand lettering, template lettering, and computer lettering, shall conform to the minimum sizes listed in table 2-1. Lettering shall conform to ASME Y14.2M. A minimum spacing of 2.5 mm (3/32 inch) should be maintained between lettering and line work to alleviate bleed in microfilming.

2.25.2.1 Typewritten Lettering. Typewriters that produce 3-mm- (0.12-inch-) high, all capital, Gothic type and ten-characters-per-inch spacing may be used for all sizes of drawings. Ribbons must be carefully chosen in order to obtain opaque letters and avoid feathered edges or smudging characteristics. On A-size formats the drawing number may be typed.

2.25.2.2 Preprinted Lettering. Rubber stamps and stickers or appliques shall not be used on engineering drawings.

2.25.3 SIGNATURES AND DATES. In order to obtain legibility, signatures and dates shall be executed with the same care as given to lettering and lines.

2.25.4 SYMBOLS. The same general rules apply to symbols as apply to lines and lettering. Symbols (geometric, tolerance, welding, etc.) shall be shown so that they will be clear and legible when reduced to 1/2 size for reproduction.

2.25.5 CROSS-SECTION AREAS. Section lines rather than shading shall normally be used when it is necessary to indicate a cross-sectional area. Wide opaque areas do not reproduce on microfilm; therefore, shading over 3-mm (1/8-inch) wide shall not be used on A- or B-size drawings. Shading over 6-mm (1/4-inch) wide shall not be used on D-, E-, F-, and J-size drawings.

2.26 DRAWING CHECKING

Drawing checks shall be required for the production of error-free engineering drawings. Some guidelines for checking drawings are given in the following paragraphs. The items listed herein are not intended to be a complete checklist for drawing checks but rather a list of those items that are usually found to contain errors during the final checking process. The drawing check shall ensure that items on a drawing are in accordance with the requirements specified in volume I of this manual.

2.26.1 QUALITY. To ensure the quality of a drawing, the following items shall be checked:

a. General appearance is good.

b. Line density and spacing is proper.

c. All arrowheads are shown.

Table 2-1. Minimum Letter and Number Sizes on KSC Aerospace and Ground Support Equipment Drawings

Item on Drawing	Minimum Letter or Number Size	
	Drawing Size	
	A and B millimeter (inch)	C, D, E, F, and J millimeter (inch)
Drawing number	6.0 (0.25)	6.0 (0.25)
Title	5.0 (0.18)	5.0 (0.18)
Subtitle and view titles	3.0 (0.12)	5.0 (0.18)
Field of drawing notes and revisions	3.0 (0.12)	3.0 (0.12)
List of notes (heading)	5.0 (0.18)	5.0 (0.18)
Vertical spacing		
Between lines of notes	1.5 (0.06)	1.5 (0.06)
Between notes	3.0 (0.12)	9.0 (.38)
Title block entries	3.0 (0.12)	4.0 (0.16)
Parts list	3.0 (0.12)	4.0 (0.16)
		3.0 (0.12)
Find number	3.0 (0.12)	3.0 (0.12)
	3.0 (0.12)	4.0 (0.16)
Reference designator, etc.	3.0 (0.12)	3.0 (0.12)
	3.0 (0.12)	4.0 (0.16)
Note: Decimal points, dashes, etc., shall be bold and shall be given one full letter space.		

d. Lettering is proper size and not crowded.

e. All erasures and corrections are properly made.

f. Drawing material is undamaged.

2.26.2 TITLE BLOCKS. To ensure the completeness of the title block, the following items shall be checked:

a. Code identification number is entered.

b. Title is correct.

c. Sheet numbering is correct.

d. Size and drawing number are properly entered.

e. Scale is shown.

f. Material is specified.

g. Tolerances are shown.

h. Dates are correctly entered.

i. Required approval signatures are entered.

j. NEXT ASSEMBLY and USED ON blocks are properly completed.

2.26.3 DRAWING PRACTICES. To ensure proper drawing practices have been followed, the following items shall be checked:

a. Notes are correctly located and information is clearly conveyed.

b. Abbreviations are correct.

c. Spelling is correct.

d. All items or assemblies are identified.

e. Symbology is correct.

f. Security classification and notes are properly located.

2.26.4 PARTS LIST. The parts list shall be checked to verify the following items have been included:

a. Identification of each item

b. Nomenclature of each item

c. Quantity and procurement references for each item

2.26.5 REVISIONS. Sheets modified by a revision shall be checked as follows:

a. All sheets modified by a revision.

(1) Revision block is properly completed.

(2) All revisions are entered in the revision block identified on the field of the drawing.

b. First sheet of a revised drawing.

(1) Drawing index shows all revised sheets.

(2) Revision block has identified all revised, deleted, or added sheets.

(3) Revision block has identified all engineering orders (EO's) incorporated by the revision.

SECTION III

DRAWING FORMAT

3.1 SIZE, FORMAT, TITLE BLOCK, AND MATERIAL

John F. Kennedy Space Center (KSC) engineering drawings shall be prepared on KSC drawing formats. The drawings shall conform to the instructions for format completion as detailed in the following paragraphs and the instructions for entries, drawing preparation, and notations as detailed in section II and ASME Y14.1. Table 3-1 lists nonmetric preprinted forms of the required formats and contains information pertinent to all sizes of finished formats. Sheet 1 of aerospace and ground support equipment (GSE) drawings is restricted to the forms listed in table 3-1; however, in addition to the formats listed, backup pages may be other KSC formats, computer printouts, etc. Backup pages shall conform to standard drawing sizes in accordance with table 3-1. See 3.10 regarding equivalent metric drawing sheet sizes. All forms shall reflect an authorized KSC form number or approved equivalent.

3.2 PREFERRED FORMATS

Drawings shall be prepared on the drawing format that best suits the scope and intent of the design drawing. The A-size format is preferred for specifications, wire running lists, patch lists, and other text or tabular design data. The B-size format is preferred for specification control drawings used to procure or maintain electromechanical components. The preferred format for fabrication, installation, and operations and maintenance documentation (OMD) is the F-size format as shown in table 3-1. Roll-size drawings (size H or J) shall only be used for schematics or diagrams where it is impractical to show the design information on an F-size format and only when authorized by the Government design organization.

3.2.1 ZONING OF DRAWINGS. All KSC drawing formats, with the exception of sizes A and B, shall be zoned. When zone markings are not preprinted on existing formats, zone areas shall be added as illustrated in figure 3-1. Vertical zones shall be uniformly spaced and identified alphabetically from the bottom of the drawing, and horizontal zones shall be uniformly spaced and identified numerically beginning at the right-hand edge of the drawing.

3.2.2 MICROFILMING ALIGNMENT ARROWHEADS. Alignment arrowheads shall be used on all drawings. When they are not preprinted, arrowheads shall be entered in the margin of the basic format as illustrated in figure 3-2. Roll-size application on alignment arrowheads shall be as outlined in 3.3.3. (See figure 3-2.)

3.3 ROLL-SIZE FORMAT

A roll-size drawing (size H or J) shall have all the basic format requirements as preprinted forms in addition to the requirements outlined in 3.3.1 through 3.3.4. Roll-size drawings shall be used only when authorized.

Table 3-1. Drawing Format List

Size Letter	Height (inches)	Width (inches)	Margin (inch)	KSC Form Number
A	8-1/2 11	11 8-1/2	(horizontal) 1/4 (vertical) 3/8	21-2 21-2C
A (continuation sheet)	11	8-1/2	1/4	21-2D
A (cable subassembly)	11	8-1/2	(horizontal) 1/4 (vertical) 3/8	21-2E
A/B	10	13		21-587
B	11	17	3/8	21-4
B (continuation sheet)	11	17	3/8	21-4B
C	17	22	1/2	21-5
C (continuation sheet)	17	22	1/2	21-5A
D	22	34	1/2	21-6
D (with parts list)	22	34	1/2	21-6D
D (continuation sheet)	22	34	1/2	21-6E
E	28	44	1/2	21-8 21-8A
E (continuation sheet)	28	44	1/2	21-8B
F	28	40	1/2	21-9
F (with 1/2-sheet parts list)	28	40	1/2	21-9C
F (with full sheet part list)	28	40	1/2	21-9D
F (continuation sheet)	28	40	1/2	21-9E
H (roll size)	28	48 Minimum 144 Maximum	See paragraph 3.3	None
J (roll size)	34	48 Minimum	See paragraph 3.3	None

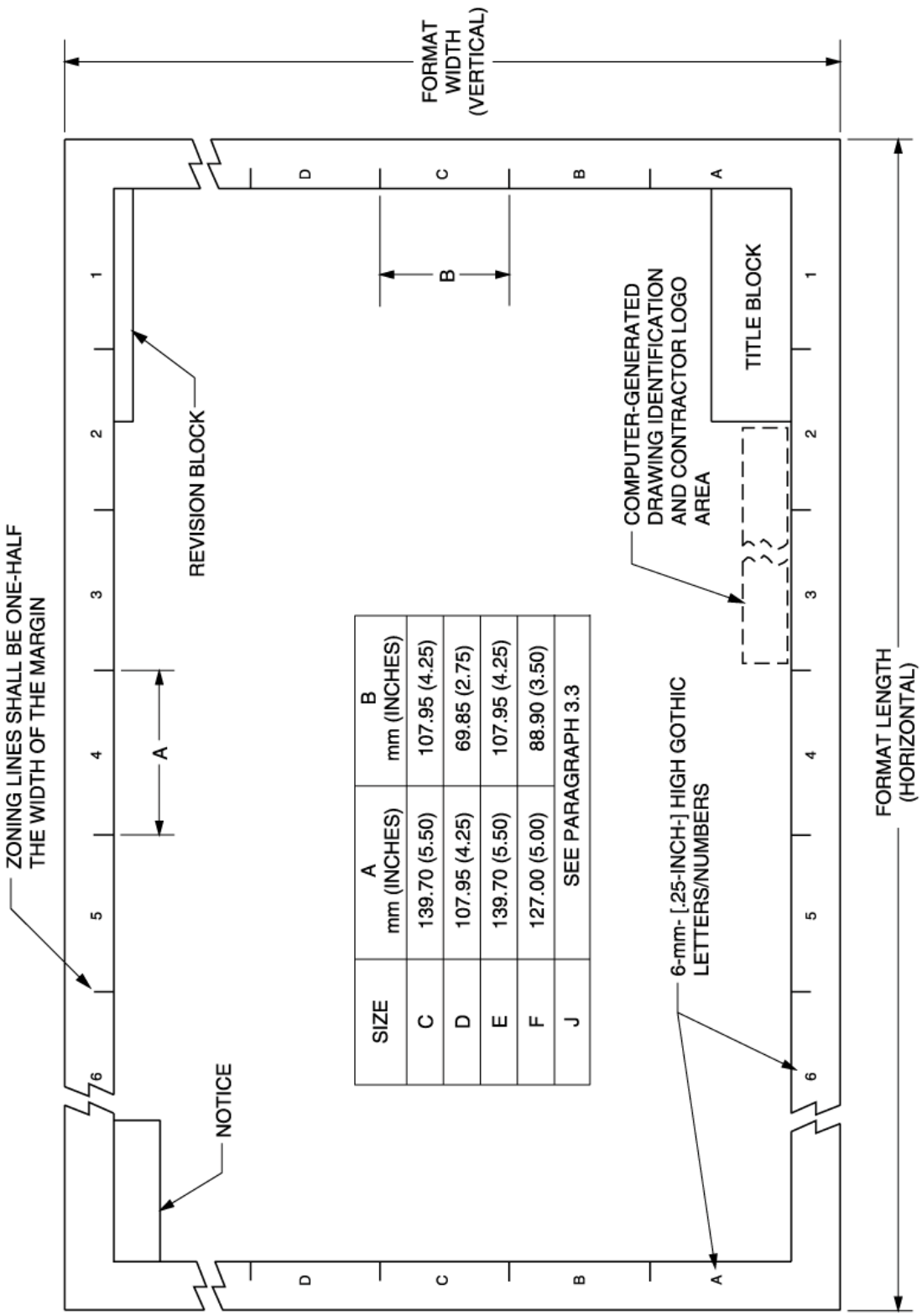


Figure 3-1. Drawing Zones

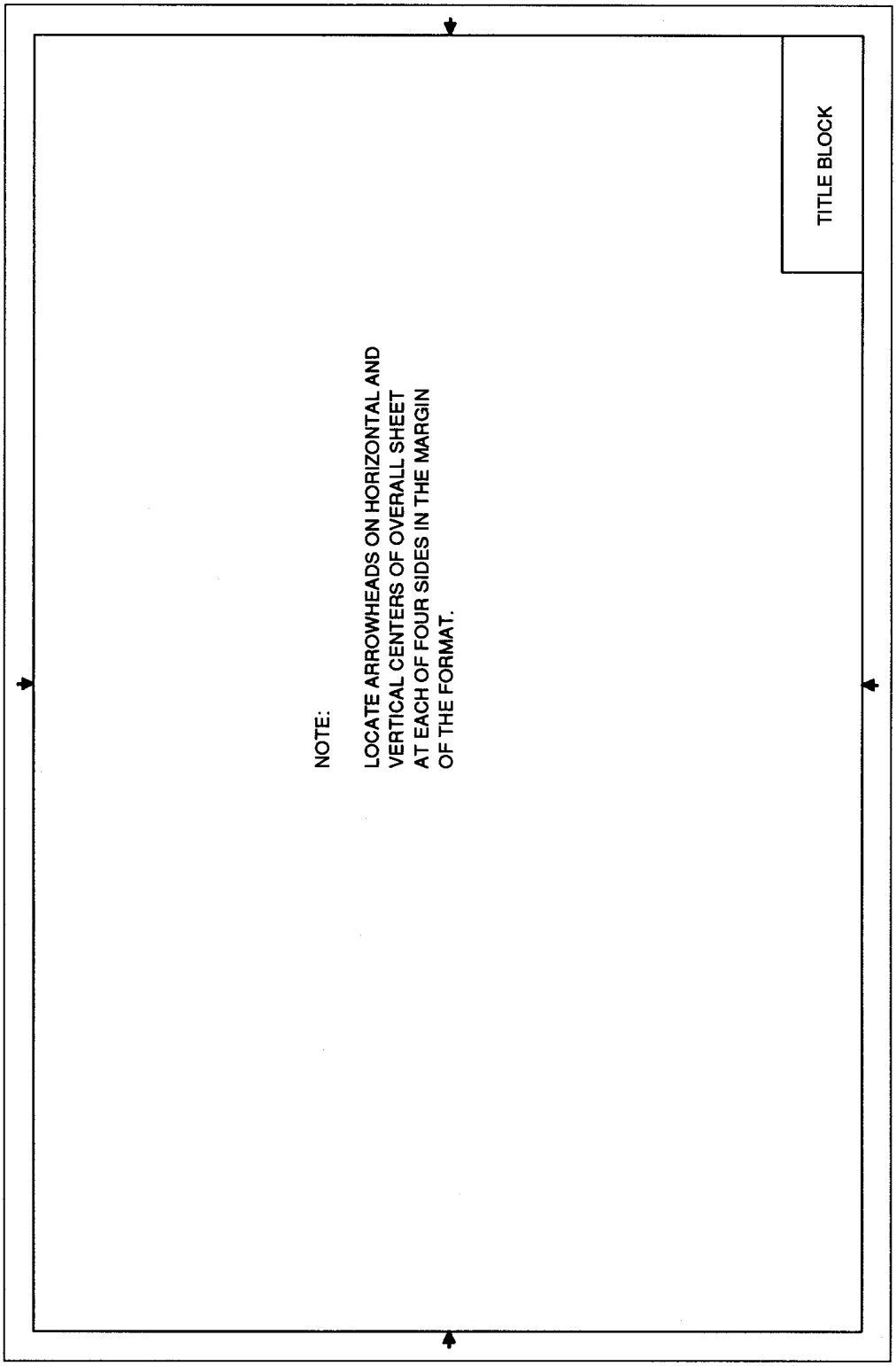


Figure 3-2. Alignment Arrowheads

3.3.1 ZONING. Zone areas for a roll-size drawing shall be spaced 108 mm (4-1/4 inches) on the horizontal and 82.5 mm (3-1/4 inches) on the vertical and shall be identified in the same manner as described in 3.2.1.

3.3.2 MARGINS. A roll-size drawing shall have a 12.7-mm (1/2-inch) horizontal margin and a 50-mm (2-inch) vertical margin (minimum) on each end with the drawing number (and sheet number for multiple-sheet drawings) entered on opposite ends so as to be readable when the drawings are rolled from either end and stored.

3.3.3 MATCH LINES - ALIGNMENT ARROWHEADS. Match lines shall be used to facilitate alignment of multiframe roll-size drawings for microfilming. Match lines shall be used on a roll-size drawing in lieu of alignment arrowheads. Alignment arrowheads shall be used to facilitate alignment of the formats shown in table 3-1 during microfilming. Alignment arrowheads shall be located in the middle of the horizontal and vertical format borders as shown in figure 3-2.

3.3.4 SUPPLEMENTAL DRAWING NUMBER BLOCKS. Roll-size drawings shall have the drawing number, sheet number, revision letter, and frame number entered in the appropriate supplemental drawing number blocks for multiframe microfilming, as shown in figure 3-3, with each frame. The supplemental drawing number block shall be located at the bottom border of the drawing adjacent to the frame match line (figure 3-3).

3.4 SECURITY CLASSIFICATION AND NOTATION

The security classification and notation shall be shown on all drawings warranting a security classification in accordance with DOD 5220.22-M and as specified in ASME Y14.100M, appendix B.

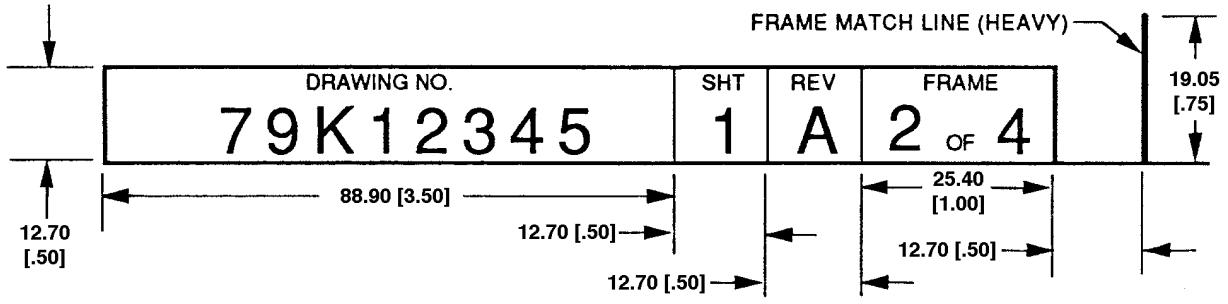


Figure 3-3. Supplemental Drawing Number Block

3.5 PARTS LIST

When a list of material, parts, or components is required on a drawing, the list shall be prepared integrally with the drawing. The size and location shall be in accordance with the requirements of this manual (see section II). Additional parts list blocks may be located to the left of and adjacent to the original block or on a continuation sheet of the same drawing.

3.6 NOTICE

The following notice should be located in the upper left corner of the drawing format as indicated in figure 3-1.

> NOTICE - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

3.7 KSC CONTRACTOR DRAWING FORMAT

Contractors that produce drawings for NASA KSC shall use the drawing formats specified in this section. In addition to these requirements, the contractor may add the company name and/or logo immediately above the title block of A- or B-size formats or immediately to the left of the title block on other format sizes.

3.8 PREPRINTED DRAWING FORMAT MATERIALS

Preprinted A-size drawing formats shall be printed on 24 lb. translucent bond paper. All drawing formats other than A-size shall be preprinted on plastic tracing sheets with a glazed matte finish conforming to L-P-00519.

3.9 COMPUTER-GENERATED DRAWING FORMATS AND MATERIALS

Computer-generated drawing formats shall comply with the requirements specified in this section, including the use of an authorized KSC form number or approved equivalent on the drawing format. In addition to these requirements, each computer-generated drawing format shall have a computer-generated drawing identification area (see figure 3-1). The identification shall contain the file name or address of the drawing and the computer system from which the drawing was generated. Computer-generated drawings and formats may be printed on paper, conforming to UU-P-56 or plastic tracing sheets conforming to L-P-00519.

3.10 METRIC-SIZE PAPER

The international standard paper sizes in the A series best correspond to standard drawing sizes in U.S. Customary units. The A series is based on a width-to-length proportion of 1 to 2 in the same manner as the A-, B-, C-, D-, and E-size formats. The relationships between the A-series sizes and the customary sizes are shown in table 3-2. The margins defined in table 3-1 will produce net drawing areas that are within the sheet sizes of both standards, so drawings may satisfactorily be reproduced on either customary or international sheet sizes by contact printing and microfilm projection methods. There are no corresponding sizes for the customary F-, H-, and J-size sheets in the international A series. The soft conversions of these customary sizes may be used and are also shown in the table.

Table 3-2. Comparison of International and U.S. Customary Drawing Sizes

INTERNATIONAL DESIGNATION	WIDTH mm (in)	LENGTH mm (in)	NEAREST U.S. CUSTOMARY SIZE	
			LETTER	SIZE (in)
A4	210 (8.27)	297 (11.69)	A	8.5 x 11.0
A3	297 (11.69)	420 (16.54)	B	11.0 x 44.0
A2	420 (16.54)	594 (23.39)	C	17.0 x 22.0
A1	594 (23.39)	841 (33.11)	D	22.0 x 34.0
A0	841 (33.11)	1189 (46.81)	E	34.0 x 44.0
	711	1016	F	28.0 x 40.0
	711	1219	H	28.0 x 48.0 (minimum)
	711	3658		28.0 x 144.0 (maximum)
	864	1219	J	(no maximum length)

SECTION IV

TYPES OF ENGINEERING DRAWINGS

4.1 GENERAL

This section defines and illustrates the types of aerospace and ground support equipment (GSE) drawings normally prepared by or for the John F. Kennedy Space Center (KSC), NASA, and identifies drawing applications and requirements for preparing drawings. Engineering drawings shall define directly or by reference the physical and functional engineering requirements of equipment by means of pictorial and textual presentation. Drawings are classified into the following types:

Advanced electrical schematic
Elementary electrical schematic
Electrical single-line diagram
Electrical two-line dc power diagram
Cable interconnect diagram
Mechanical schematic
Electromechanical control diagram
System mechanical schematic
System block diagram
Ground integrated schematic
Logic diagram
Functional flow diagram
Specification drawing
Component maintenance drawing
Cable harness drawing
Cable assembly drawing
Cable subassembly drawing
Cable installation drawing
Printed-wiring drawing
Assembly drawing
Detail assembly drawing
Detail drawing
Arrangement drawing
Envelope drawing
Installation drawing
Space allocation drawing
Matched-parts drawing
Altered-parts drawing
Modification drawing
Layout and proposal drawings

Undimensioned drawing
Block diagram
Sketch drawing
Interface control drawing
System/equipment parts list
Electrical wire running list
Patch list
System/equipment documentation list
Index list
Electrical power riser diagram
Electrical panel schedule
System mechanical schematic/electromechanical control diagram (SMS/EMCD)
Standard interface document
Hardware interface module (HIM) configuration document (HCD)
Operation and maintenance requirements and specifications document (OMRSD)

4.2 ADVANCED ELECTRICAL SCHEMATIC (AES)

An advanced electrical schematic illustrates and defines electrical signal and power paths, detailed electrical connections, and functions of component items used within a specific circuit or system of circuits by means of graphic symbols. Complete and formal titles and reference designators of each component are identified. Indication of physical size, shape, or relative location of components is not required.

4.2.1 DEFINITIONS.

a. Box. A box is a rectangular symbol used in the body of the drawing. The box denotes a complete functional electrical item or assembly, designed to be replaceable as a unit, that is integrated into the electrical system.

b. Continued Circuit Symbol. A continued circuit symbol (ballout) is a split circle used to indicate connections from sheet to sheet and may also be used to avoid crossovers on the same sheet.

c. Division Line. A division line is a solid thick line used to separate major unit areas to reflect interunit cable interfacing and to represent bulkhead plates.

d. Major Unit. A major unit is a physical entity of an electrical system composed of basic parts, subassemblies, or assemblies packaged or combined together and is capable of normal independent operation.

4.2.2 APPLICATION. An advanced electrical schematic shall be used to support system testing, troubleshooting, and operating procedure preparation. (See figure 4-1.)

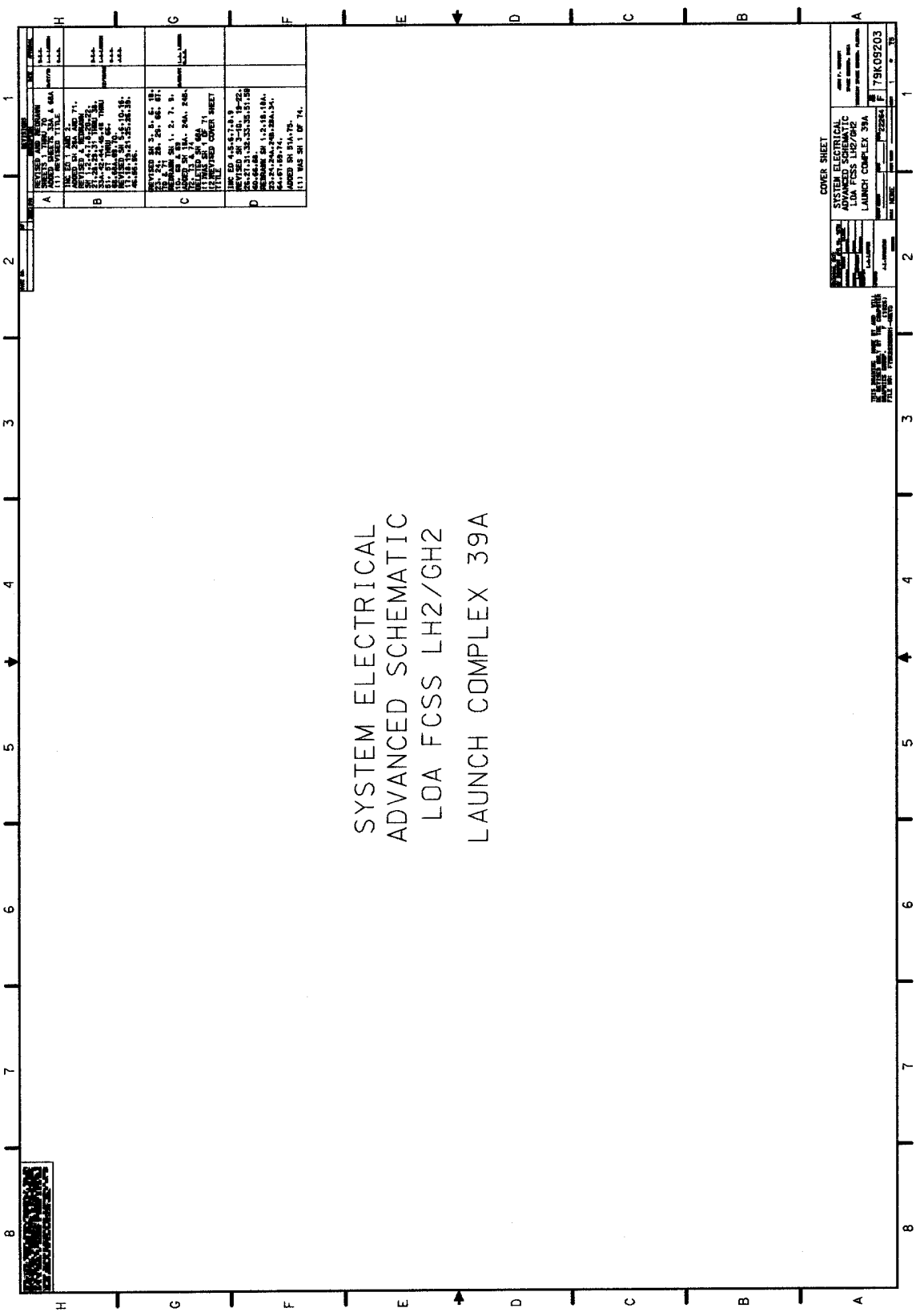


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 1 of 8)

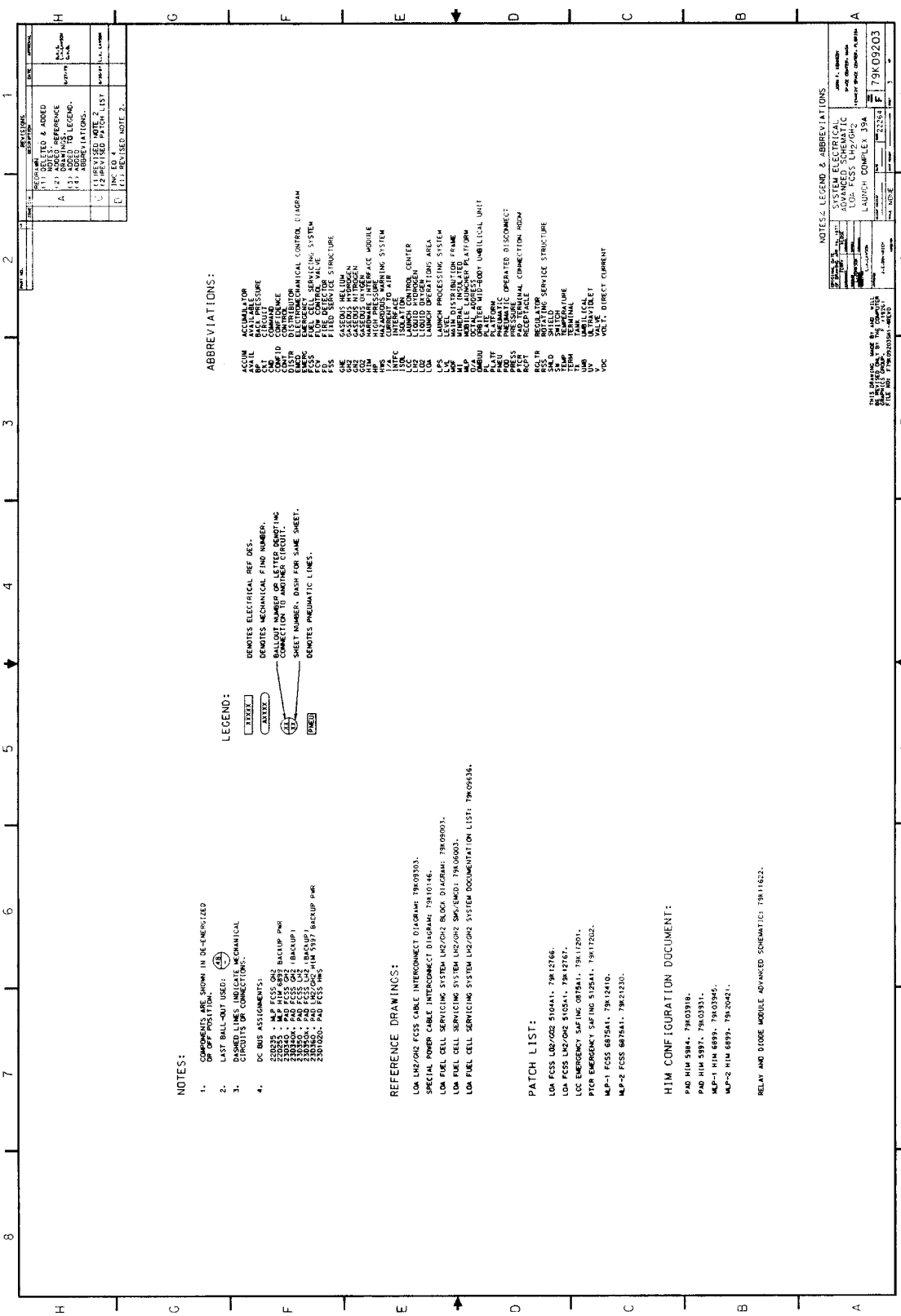


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 2 of 8)

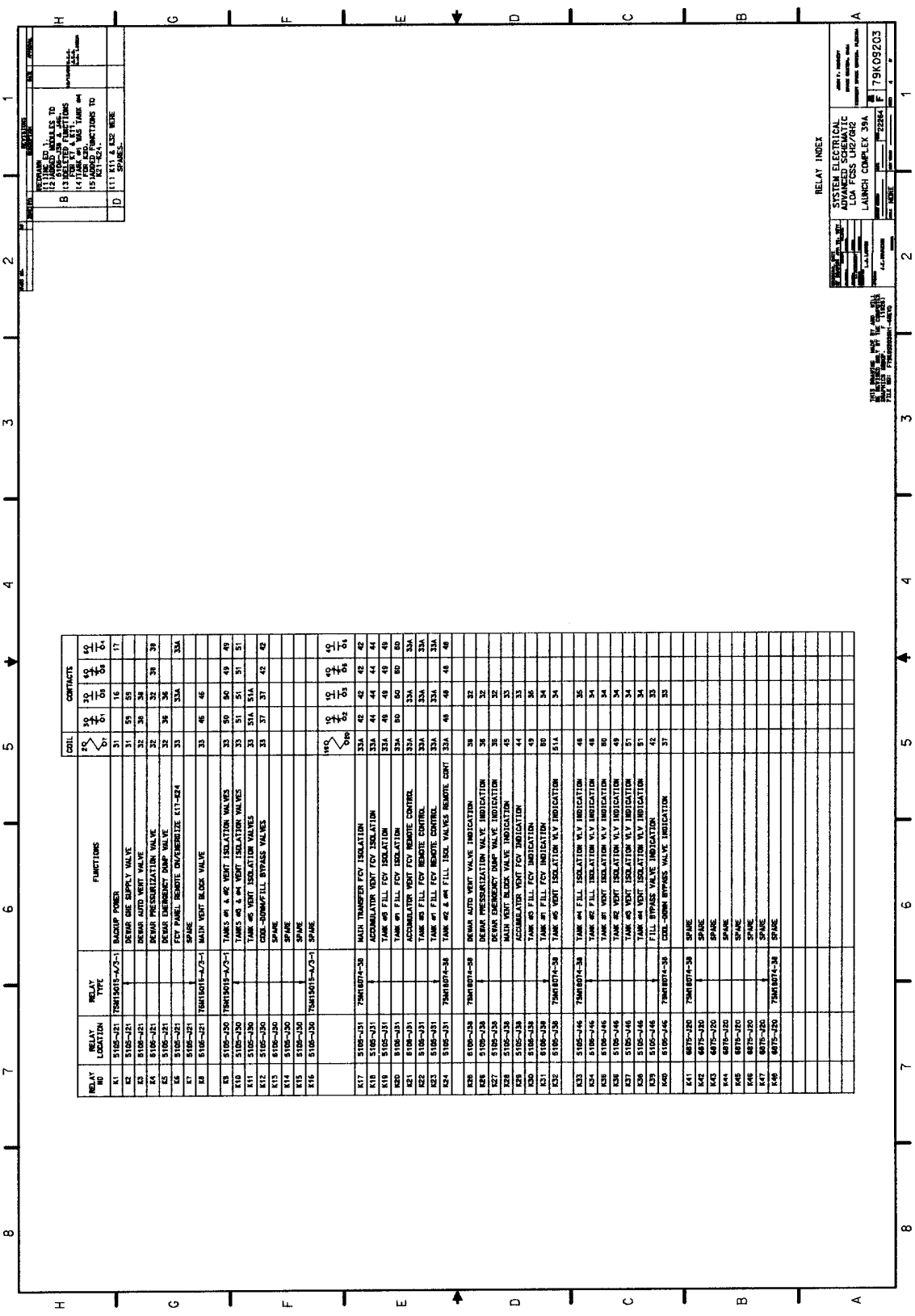


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 3 of 8)

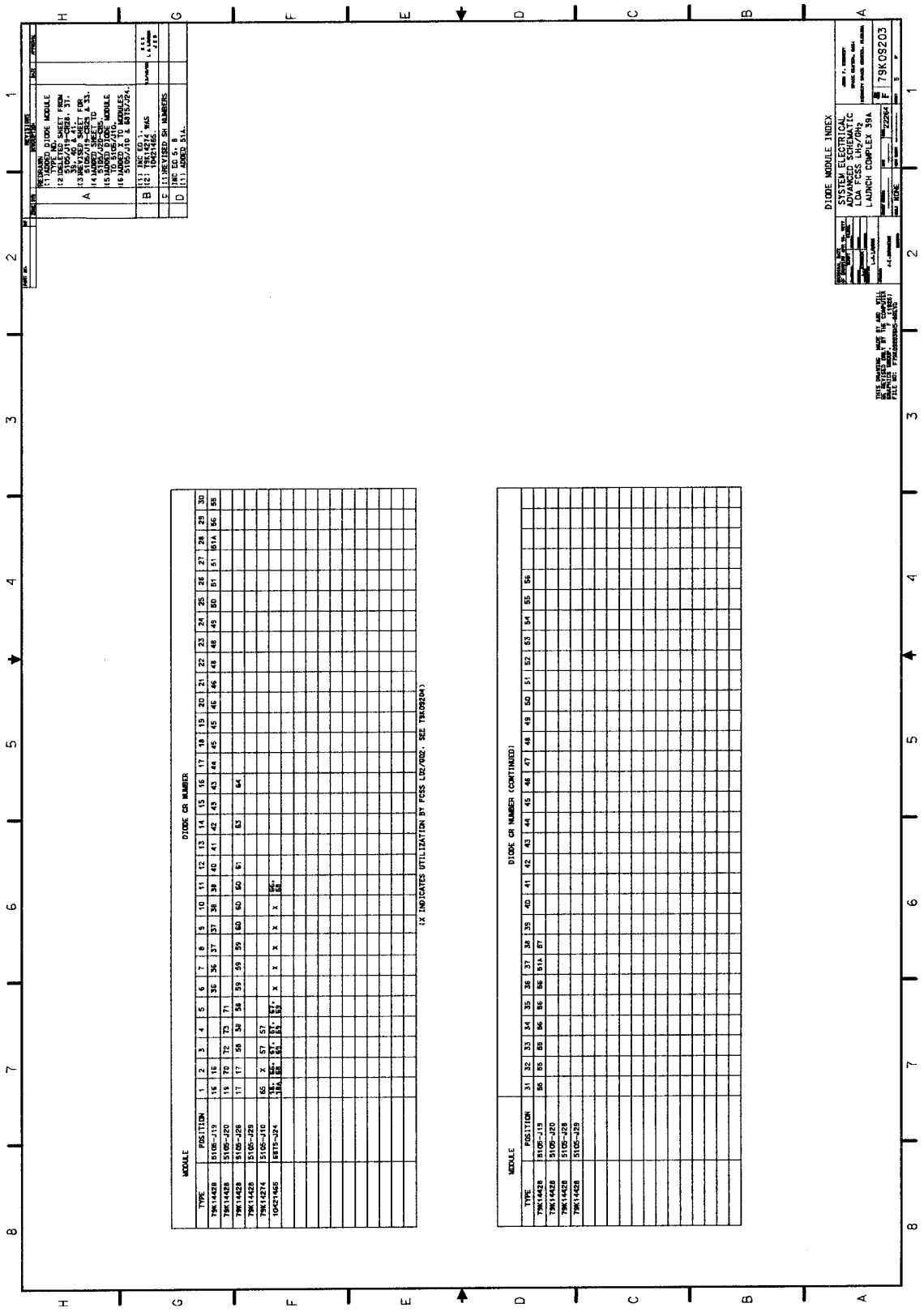


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 4 of 8)

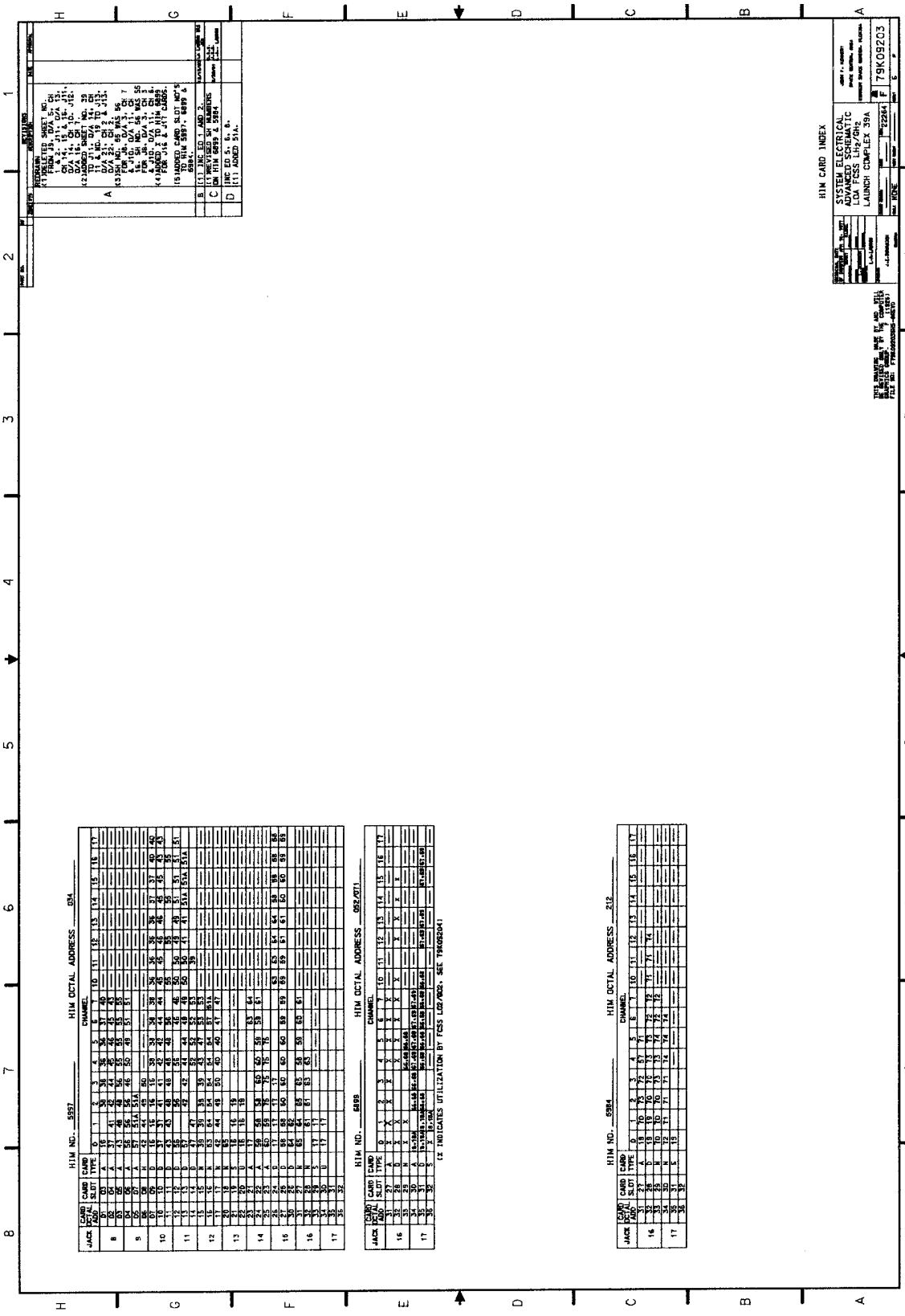


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 5 of 8)

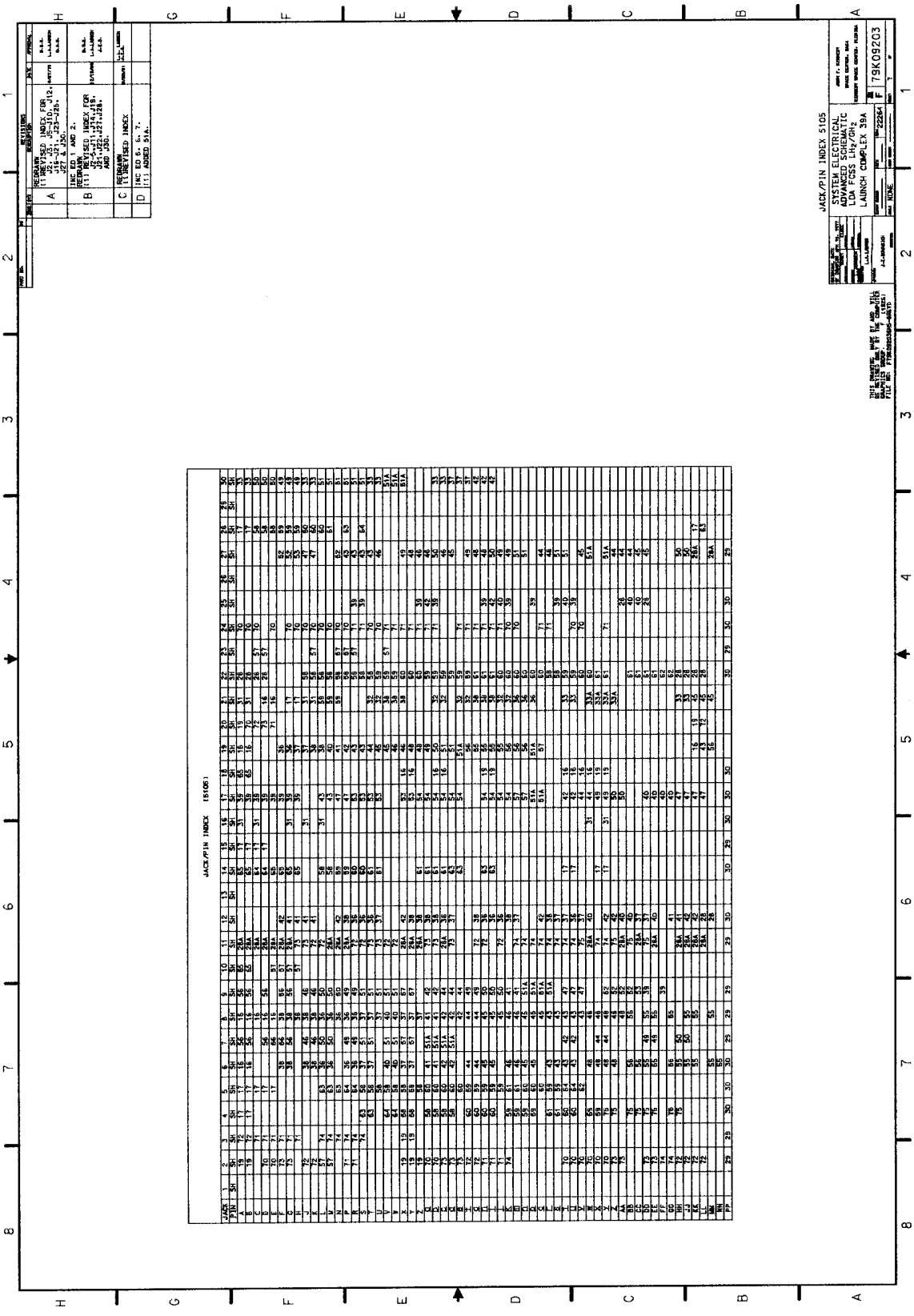


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 6 of 8)

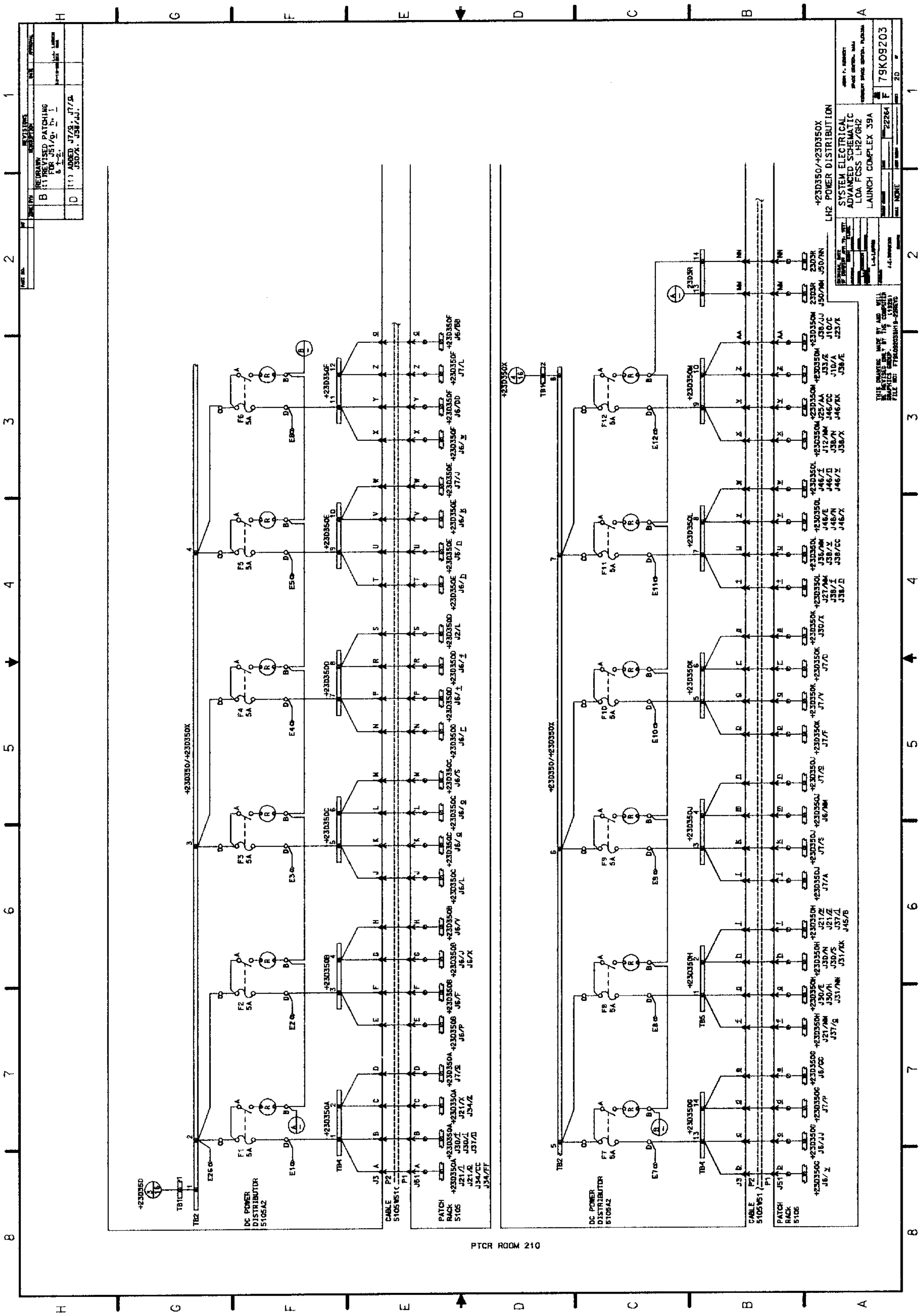


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 7 of 8)

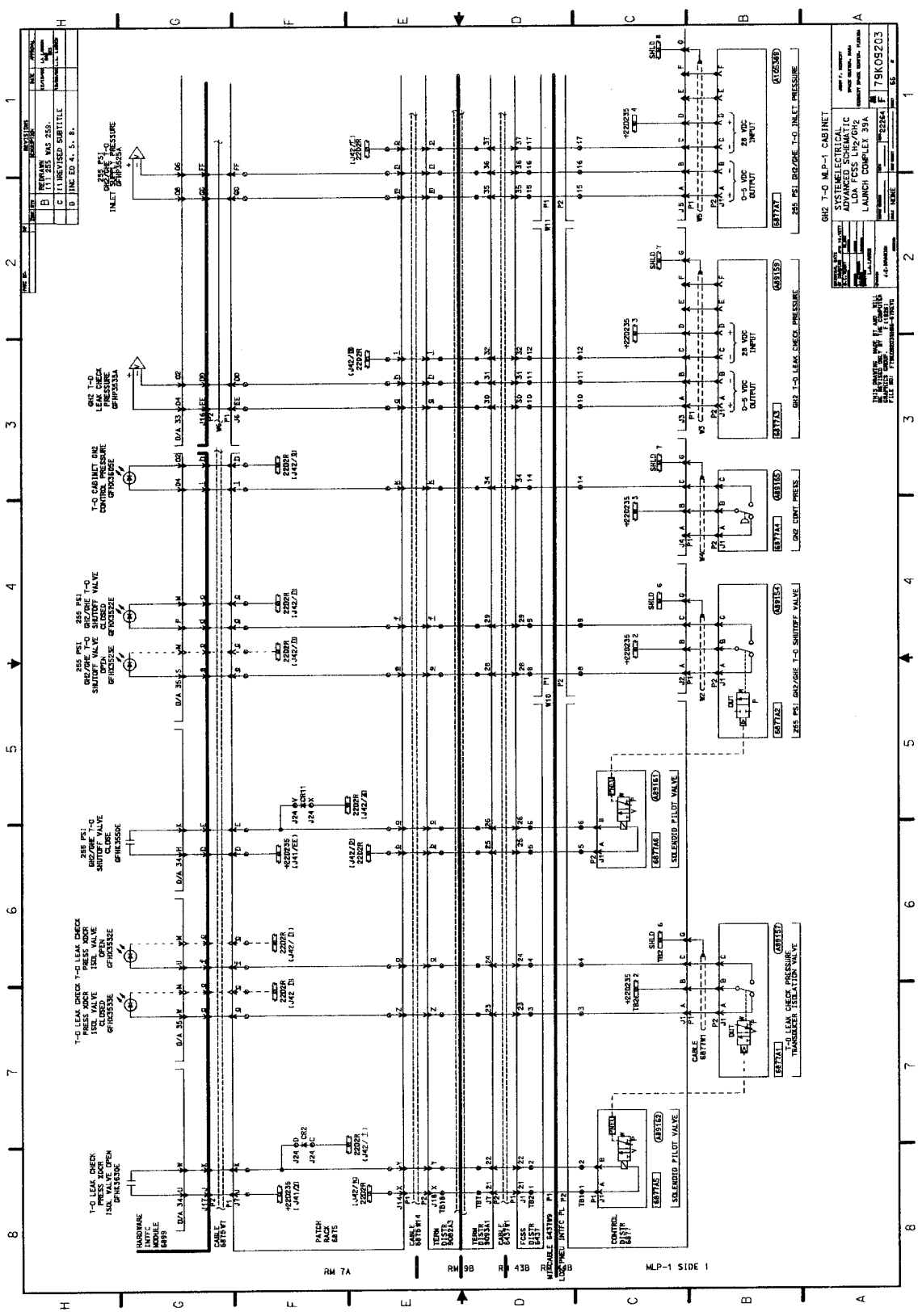


Figure 4-1. Typical Advanced Electrical Schematic (Sheet 8 of 8)

4.2.3 REQUIREMENTS.

a. Organization. An advanced electrical schematic shall contain the following parts arranged in the sequence shown. (See figure 4-1.)

(1) Cover Sheet

(2) Index and Revisions

(3) Notes, Legend, and Abbreviations

(4) Relay Index

(5) Diode Module Index

(6) HIM Card Index

(7) Jack/Pin Index (if used)

(8) AC and DC Power Distribution Sheets

(9) Shield Termination Sheets

(10) Hardwire Control Sheets

(11) Schematic Sheets

b. Size. An advanced electrical schematic shall be drawn on an F-size drawing format or as determined by the responsible design organization. The drawing shall be of sufficient size to retain clarity when the drawing is reduced to a B-size sheet.

c. Standardization. Dimensions of boxes should be standardized. Whenever practicable, the vertical dimensions of boxes shall be the same for a given set of drawings.

d. Layouts.

(1) Functions. Drawings should be arranged with the major or primary functions in a straight line and the minor, supporting, or secondary functions branched off from the main functions.

(2) Conductors. An electrical conductor (wire) shall be shown as a single solid line, which should normally be drawn vertically or horizontally (except for multiple-line terminations to a common terminal). Sequential terminal or connector

contact numbering may be disregarded in order to avoid or minimize crossed lines and provide a conductor path as short and direct as possible.

(3) Crossed Conductors. A conductor may cross one other conductor if the use of 13-millimeter (mm)-(1/2-inch-) diameter ballouts would result in a symbol (ballout) interference or impede circuit readability. All such crossed conductor lines shall intersect at right angles. Crossovers of inclined or curved portions of multiple lines (feeders) to a common terminal shall also intersect at right angles by choice of an angle or radius.

(4) Continued Circuit Symbol. The top half of the continued circuit symbol [13-mm-(l/2-inch-) diameter ballout] shall indicate the circuit reference character; the lower half shall indicate the sheet number where its circuit continuation is located. A short solid line in the lower half shall indicate a continuation on the same sheet. A letter is used for the top-half character in a ballout on the same sheet, beginning with the letter A on any given sheet. Circuit numbers shall be assigned consecutively throughout the drawing package. The last numbered ballout used shall be entered in the general notes on the Notes, Legend, and Abbreviations sheet. (See figure 4-1.)

(5) Alignment of Symbols. Symbols shall be horizontally aligned and drawn vertically whenever possible.

(6) Spacing of Symbols. Symbols shall be spaced so that connecting conductor lines are as straight as possible (without offset).

(7) Box Alignment. The alignment of related boxes should be systematic and logical.

(8) Connecting Line Arrangement. Boxes shall be arranged so that connecting conductor lines are drawn as straight as possible (without offset).

e. Cover Sheet. The drawing package title shall be positioned in the middle portion of the sheet. Lettering shall be uppercase Gothic and shall be 13 mm (1/2 inch) high (minimum).

(1) Title Block. All lettering in the title block shall be uppercase Gothic and shall be 5 mm (3/16 inch) high (minimum). Area locations may be abbreviated.

(2) Subtitles. Subtitles and/or sheet descriptions (e.g., Cover Sheet, Index, and Revision, etc.) shall be entered above the title block. Lettering shall be uppercase Gothic and shall be 5 mm (3/16 inch) high (minimum).

f. Drawing Number. Drawing numbers shall be assigned in accordance with the provisions of this manual. Number size shall be 5 mm (3/16 inch) high (minimum).

g. Reference Designators. Reference designators shall be in accordance with MSFC-STD-349.

h. Symbols. Electrical symbols shall be made in accordance with KSC-STD-152-2.

i. Buses. In general, buses shall be aligned horizontally. When two or more common buses are adjacent (except those within a patch rack), they may be joined to form one bus. Except for jumpers and special cases, wire shall not be shown from top to bottom for the same bus symbol.

j. Terminal. In general, terminals shall be aligned horizontally.

k. Cables. Electrical cables shall be shown as a number of solid (conductor) lines in groups that are separated by breaks in the horizontal division lines of major units. These breaks shall be used to show changes in cables and connectors. Electrical cable grounding configurations shall be shown in accordance with the prescribed shield grounding schematic format as specified in KSC-STD-152-2. A dashed double-line shield band centered between the horizontal division lines and crossing conductor lines shall be used to designate overall shielded cables. Break symbols on the ends of the shield bands may be used to indicate a continuation of the cable composition and/or a ground circuit delineation on another sheet. Each conductor within the cable shall terminate at a connector contact or terminal symbol.

1. Lettering. Lettering templates and/or other mechanical devices shall be used for all drawing text. Lettering in the field of the drawing shall be uppercase Gothic and shall be 5 mm (3/16 inch) high (minimum) for headings (e.g., legend, general notes, abbreviations, etc.) and shall be uppercase Gothic and 3 mm (1/8 inch) high (minimum) for general text. Electrical connector pin designations normally shown with lowercase letters shall be shown on drawings with underlined lowercase letters. In all cases, lettering shall be large enough to permit reduction to B-size drawings without loss of readability.

m. Major Unit Designations. Lettering for major unit designations shall be placed within the left side of the box where the unit starts on the sheet. All major unit boxes shall be closed on the left side even though the box is a continuation from the previous sheet.

n. Part Reference Designators. Short sign reference designators complete with terminal identifications for buses (including patch points) shall be located to the side opposite the conductor terminations on the symbol. Short sign part reference designators for other parts (e.g., relays, diodes, resistors, fuses, capacitors, heaters, switches, valves, etc.) shall be located to the right side of a vertically (preferred) drawn part symbol or

above a horizontally drawn symbol. The short sign reference designator of a part containing a series of terminal, or contact points spaced horizontally in alignment [e.g., hardware interface module (HIM) cards, connectors, and terminal boards], shall be located to the left side of the first symbol only. A slash (/) shall be used to separate part reference designators from terminal or contact designators when shown together (e.g., J1/A, TB3/9, etc.).

o. Connection Identification. Part terminal or contact identifications (e.g., numbers, letters, or combinations of both) shall be located to the right side of a vertically (preferred) drawn part symbol or below a horizontally drawn symbol. Where a terminal board and associated jack have the same contact number, the terminal number shall be omitted from the drawing.

Mounted connector reference and contact identifications shall be located within their respective unit or box enclosures and shall be located below the horizontal lines representing bulkhead plates.

p. Connector Labels. At umbilical and staging electrical interfaces, each connector shall be identified by name and by electrical reference (e.g., J1 umbilical No. 3).

q. Electrical Parameters. Ohmic and wattage values shall be located to the right of the component. If components are drawn along a horizontal line, these numbers shall be located under the component.

r. Part Functional Reference. A sheet number enclosed by parentheses and located to the left side of a symbol that represents a part of a multielement device (e.g., relays) may be used to indicate the principal drawing sheet in which the functional description of that device is delineated.

s. Box Labels. Boxes shall be labeled on schematics with the official title and electrical reference designator, except for independent transducers in the instrumentation system. These transducers shall be identified by electrical reference designator and transducer type or measurement number. Electromechanical components (e.g., solenoid valves) shall also show the mechanical find number.

t. Circuitry in Boxes. Boxes that functionally need to be explained pin by pin shall either show the detail circuitry or show the operation by use of symbolism. Symbology is to be used whenever possible to avoid cluttering system schematics within component boxes.

u. HIM Card Labels. HIM cards shall be identified with the card octal address, the channel number, the measurement number, and the function description.

v. General Notes. Notes and flag notes applicable to all drawing sheets shall be listed in numerical order, shall be entitled "Notes," and shall be located on the Notes, Legend, and Abbreviations sheet.

w. Mechanical Components. When solenoid valves are used to control pneumatic components, the solenoid valve, its controlled pneumatic component, and the feedback signals shall all be shown on the same sheet.

4.3 ELEMENTARY ELECTRICAL SCHEMATIC (EES)

An elementary electrical schematic contains much of the same information as an advanced electrical schematic except that wire routings and most of the detailed wire connections of the component items are omitted. These diagrams show all black boxes that are on the advanced schematic with sufficient detail to identify components and black-box functions. The schematic shows components in their functional relationship and is not restricted to drawing location by black-box outlines. Cross-reference information between the elementary electrical schematic and the electromechanical control diagram is shown. Hydraulic/pneumatic control circuits may also be shown. (See figure 4-2.)

4.3.1 APPLICATION. An elementary electrical schematic shall be used for electrical control and monitoring of all ground support systems (including electrical, mechanical, fluid, and pneumatic systems), 28-volt direct current (dc) power supplies, and control and monitoring systems for alternating current (ac) power systems. An elementary schematic is also used for trouble-shooting, operational analysis, software programming, reliability studies, logic simplification, modification requirement evaluation, modification design development, and understanding and communication among design, sustaining, and operations personnel.

4.3.2 REQUIREMENTS. An elementary electrical schematic shall show each circuit and component of a system from end to end. The front end of a circuit may be a specific interface with a designated circuit on another system drawing as a support function. The service end shall be shown so that every circuit reflects connections to all of the devices and elements therein. The schematic shall be either horizontal or vertical ladder type. (Industry-type drawings shall be used for elevators.) Each circuit across the ladder shall include all devices and elements with each black box shown with its equivalent devices and elements within a dashed-line enclosure. Where equivalent or simplified circuits are used to show the logic within a black box, J-designators and dotted circuit lines shall be used to indicate an imaginary circuit rather than an actual circuit representation.

The following requirements shall also apply to elementary electrical schematics:

a. The drawing shall include primary, redundant, and backup circuits and components, as well as all local and remote control, indication, and recording circuits. General location code, electrical reference designator, name, and measurement number shall be shown for each device and element.

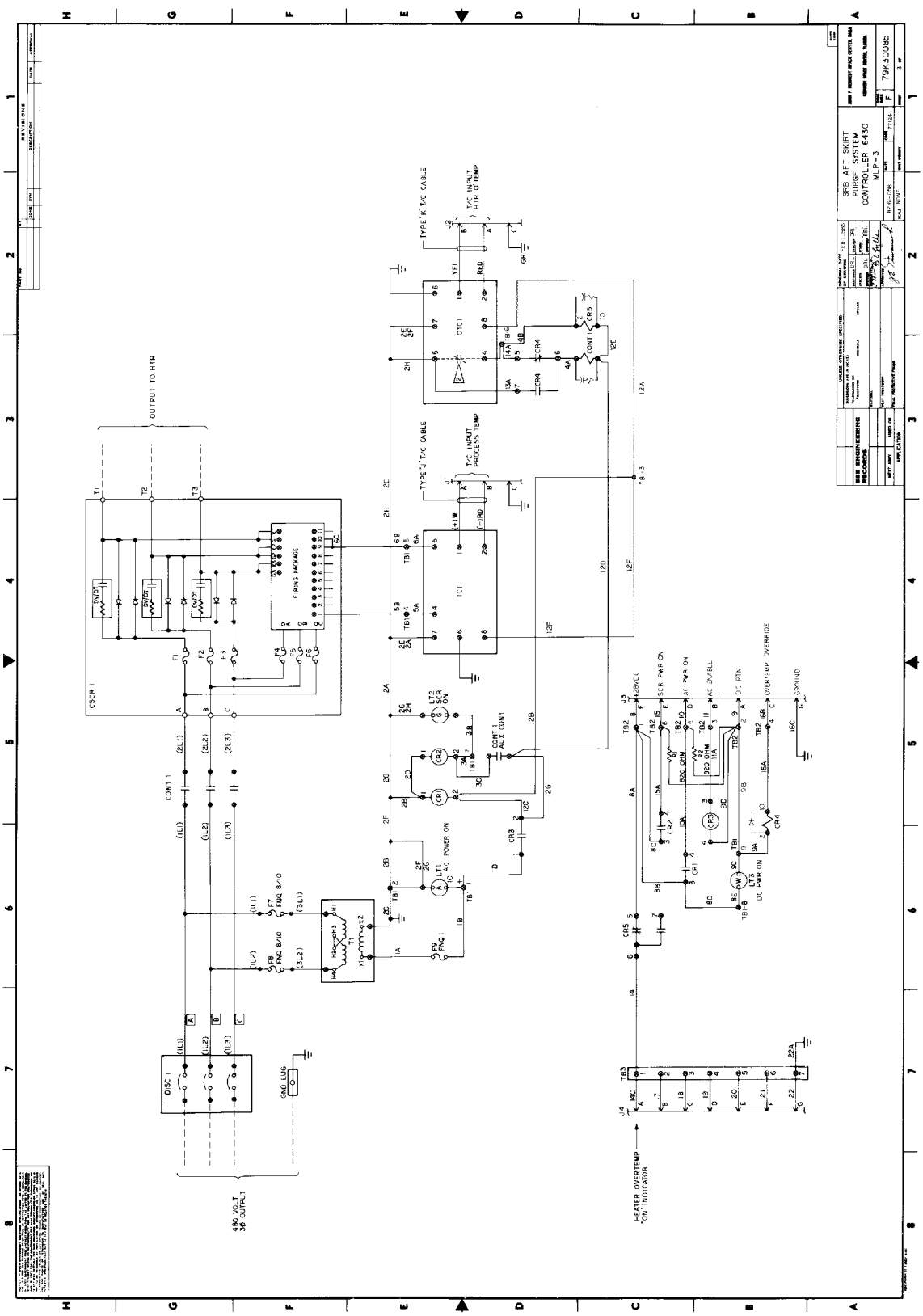


Figure 4-2. Typical Elementary Electrical Schematic

b. The drawing shall show the system in a deenergized condition.

c. A related group of circuits shall be identified by a title at the top of the drawing naming the general function of the group. The title shall be centered over each group with extension lines indicating the total span of the group.

d. Buses shall be drawn horizontally where possible, with positive at the top and negative at the bottom. Bus lines shall be identified in each zone in which they appear. If segmented, each segment shall be identified. Bus lines may be shown as identified line segments.

e. The schedule of circuit elements and devices shall show the schematic location and function of contacts, relays, switches, controls, and monitoring devices. This schedule, which shall appear in right-hand zones, shall include all spare contacts and relays.

f. When required for positive operational configuration display, switch contact schedules shall be included to indicate the position of multiple contact devices (such as drum, cam, and selector switches) and to explain when limit switches are tripped from the position shown on the elementary control diagram.

g. Hydraulic/pneumatic control circuits may be added, if required, to show the total system control on one schematic.

4.4 ELECTRICAL SINGLE-LINE DIAGRAM

An electrical single-line diagram shows, by means of single lines and graphic symbols, the course of each electrical circuit and the component devices or parts used. It omits much of the detailed control and monitoring information shown on an advanced electrical schematic.

4.4.1 APPLICATION. An electrical single-line diagram shall be applicable to all ac power systems used for transmission, generation, distribution, and secondary services of electrical energy for such ground support equipment as the Mobile Launcher Platform (MLP). The diagram shall also cover grounding systems and constant current and constant potential exterior lighting systems.

4.4.2 REQUIREMENTS. An electrical single-line diagram shall show each system from end to end. An end of a system may be a specific interface with another designated system, such as a support or a service function. The operational and maintenance interfaces of the system with other support or service systems shall be shown. Each system shall include all functions required to operate and maintain the system.

The following requirements shall also apply to electrical single-line diagrams:

a. All circuits, protective devices, switch devices, switching stations, transformers, etc., shall be identified by electrical reference designators. Each cable shall be identified by cable and wire number. Each device and element shall be identified and noted with its rating, description, and location.

b. Each switch device and breaker shall be shown in its proper open or closed position when the power system is in the normal operating configuration. Protective relay settings, fuse sizes, and breaker ratings shall be included.

c. A physical relationship of control and monitoring devices to power systems shall be shown.

4.5 ELECTRICAL TWO-LINE DC POWER DIAGRAM

An electrical two-line dc power diagram locates power supplies, electrical service, and dc power distribution within a structure such as the MLP. The room or area location of the components shall be noted.

4.5.1 APPLICATION. An electrical two-line dc power diagram shall be used for all dc power distribution systems.

4.5.2 REQUIREMENTS. On an electrical two-line power diagram, distribution panel boards shall be drawn by two lines showing common trip/tie handle breakers, as applicable. Wire numbers and terminations shall be identified, and all spare breakers and unused spaces shall be shown. All circuits, protective devices, and panel boards shall be identified by electrical reference designation. The positive and negative circuit paths shall show separate buses, conductors, breakers, and fuses. Fuse size shall be shown. Frame sizes and trip ratings for all breakers shall be given. Operational and maintenance interfaces of the system with other support or service systems shall be included on the drawing.

4.6 CABLE INTERCONNECT DIAGRAM (CID)

A cable interconnect diagram is a graphic presentation of the arrangement of controlled electrical elements or assemblies necessary for a system to perform its intended function without necessarily considering actual physical size, shape, or detailed locations. Cable interconnect diagrams are electrical block diagrams that identify controlled elements or assemblies by listing the drawing or document number that currently defines each one. The system specifications and all system interface control documents are identified by their current document number. In addition, the block diagram format shows the functional relationship of system elements as well as the functional location of interfaces.

4.6.1 DEFINITIONS.

a. Controlled Element or Assembly. A controlled element or assembly is the lowest element or assembly to be defined on a cable interconnect diagram but is essential to the function, logic, flow, and operation of the system. They are identified by part numbers, find numbers, and/or reference designator numbers.

b. Noncontrolled Element. A noncontrolled element is a system element that is not defined on the cable interconnect diagram.

4.6.2 APPLICATION. A cable interconnect diagram shall be used to provide a means of establishing and maintaining an electrical configuration baseline at the controlled element and/or assembly level. The diagram does this by identifying the currently installed electrical components and assemblies in each system and by specifying the documentation that must be maintained current as a minimum. (See figure 4-3.)

4.6.3 REQUIREMENTS. A cable interconnect diagram shall contain sufficient information to establish and define those design elements and parameters that are essential to describe the intended function and use of a system. The cable interconnect diagram is the top drawing for electrical control systems. All drawings categorized as cable interconnect diagrams shall be prepared in accordance with the following requirements:

a. General. All cable interconnect diagrams, whenever possible, shall read functionally from left to right and top to bottom beginning at input or source and ending at output, designation, or load. The drawings shall be arranged with the major or primary functions in a straight line and the minor, supporting, or secondary functions branched off from the main function. The diagrams shall be prepared and maintained to reflect the as-designed configuration. Lines should normally be vertical or horizontal and as short and direct as possible, with a minimum of crossovers. Crossing lines shall intersect at right angles. The drawing shall be structured to place symbols in the same relative location as the actual equipment to the maximum degree possible. To adequately describe the system function or control logic, operations or design criteria, parameters, and characteristics may be included in the diagrams. The size of all lettering and numbers shall be such that prints of drawings are still legible when reduced to B-size format. A system cable interconnect diagram shall be on a single drawing sheet, if possible.

b. Organization. A cable interconnect diagram shall consist of the following sections arranged in the sequence shown:

(1) Title, Index, Legend, and Abbreviations Sheet. The title, index, legend, and abbreviations sheet shall be sheet 1 and shall contain the following:

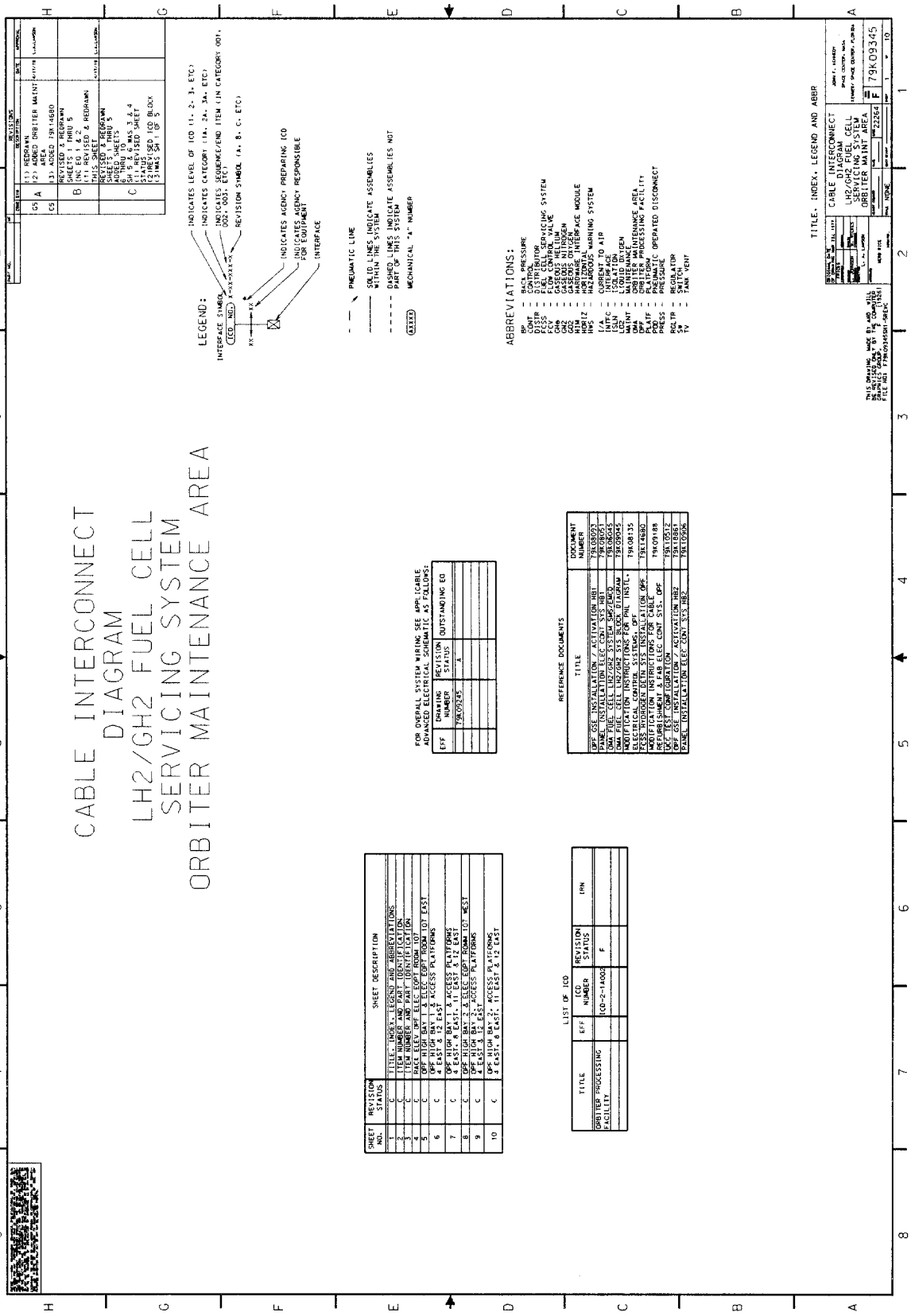


Figure 4-3. Typical Cable Interconnect Diagram (Sheet 1 of 4)

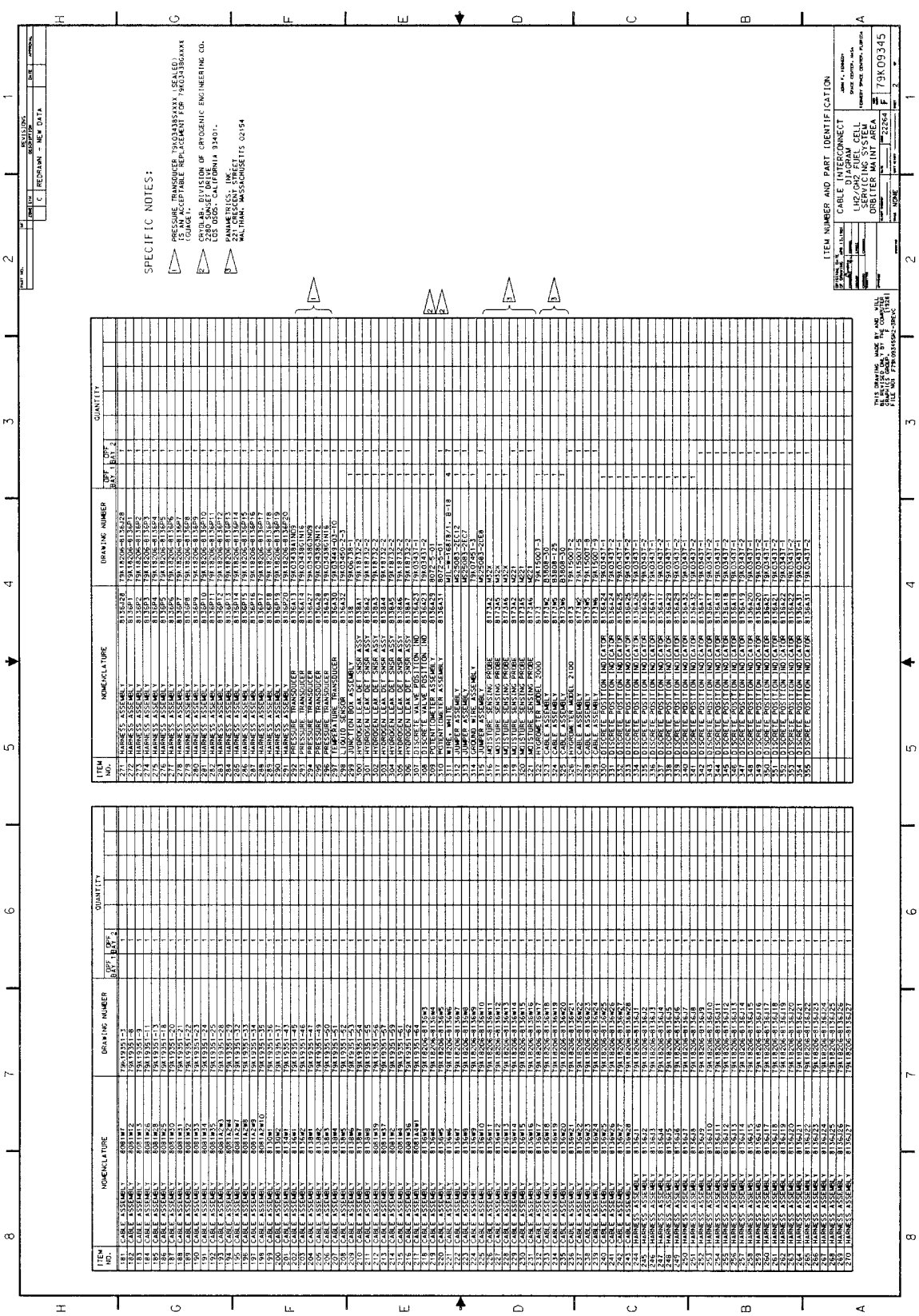


Figure 4-3. Typical Cable Interconnect Diagram (Sheet 2 of 4)

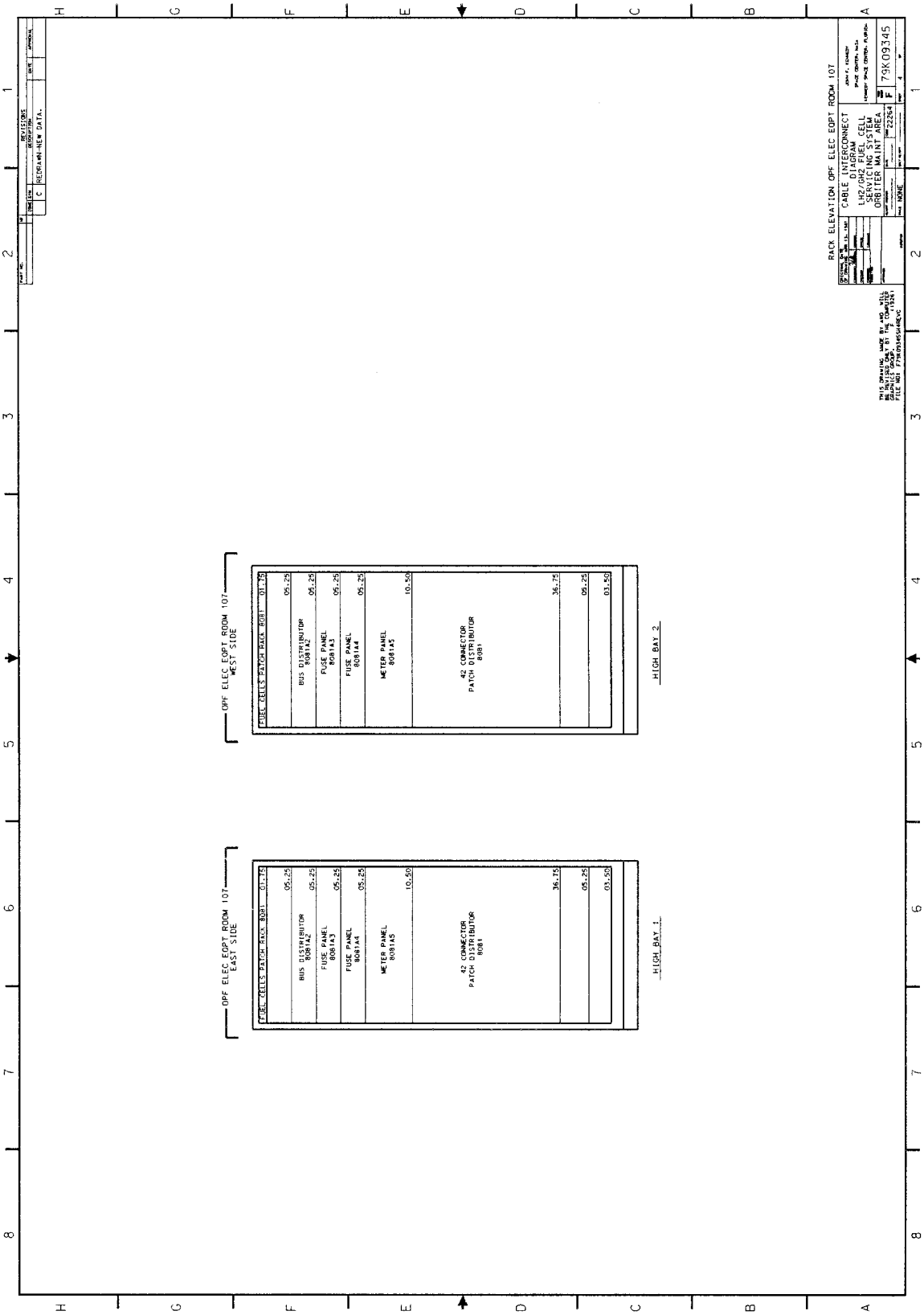


Figure 4-3. Typical Cable Interconnect Diagram (Sheet 3 of 4)

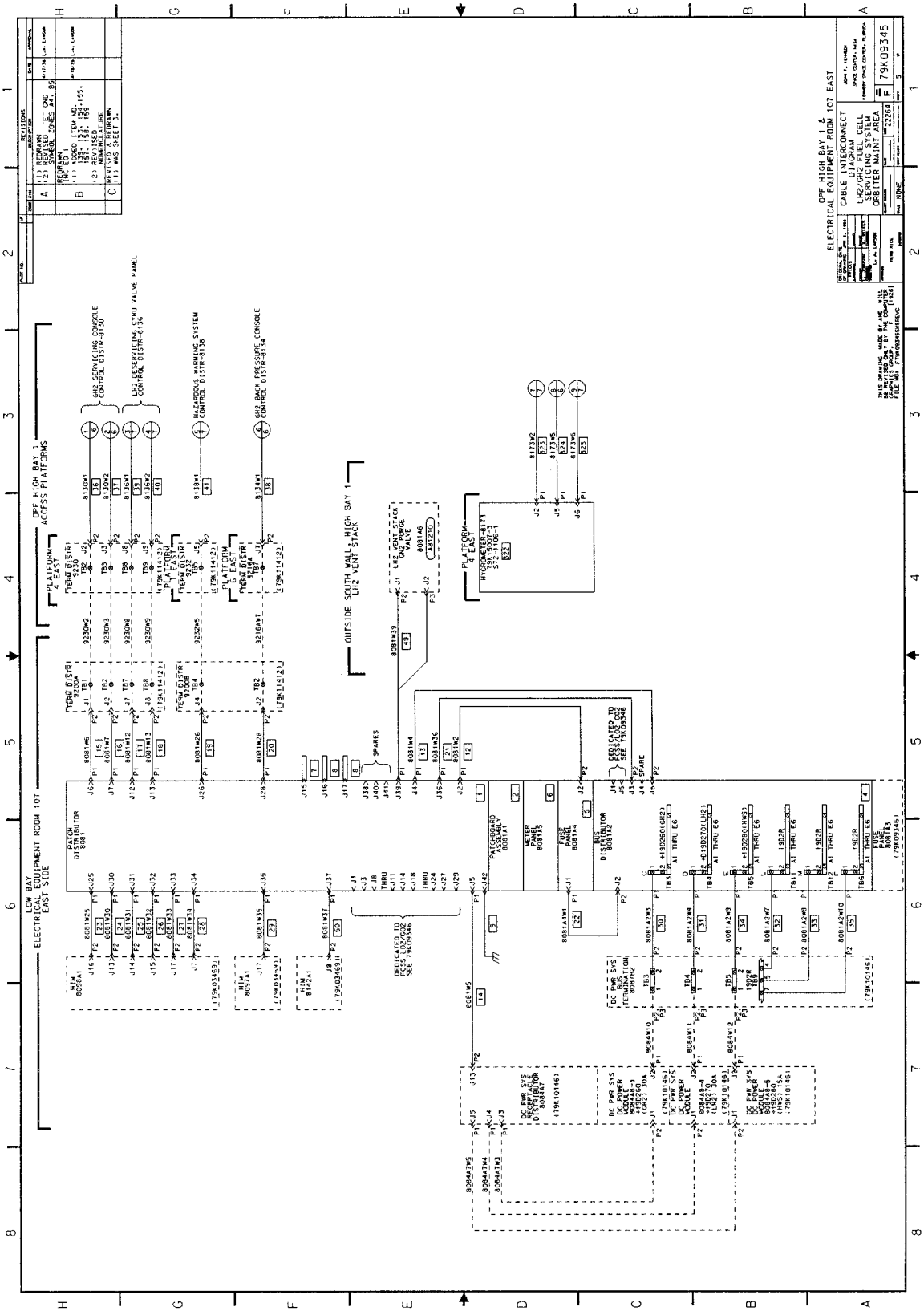


Figure 4-3. Typical Cable Interconnect Diagram (Sheet 4 of 4)

(a) The title, including the system name, area, and system model number, shall be positioned in the upper middle portion of the sheet. Lettering shall be uppercase Gothic and 13 mm (1/2 inch) high (minimum).

(b) Title block lettering to be uppercase Gothic and 4 mm (5/32 inch) high (minimum).

(c) Drawing sheet descriptions (e.g., title and index, item number and part identification, interface locations, etc.) to be entered directly above the title block. Lettering shall be uppercase Gothic and 4 mm (5/32 inch) high (minimum).

(d) A table listing the title and revision status of all sheets included in the drawing package.

(e) A table listing all interface control drawings (ICD's), their titles, revision status and interface revision notices (IRN's) applicable for the system being documented (physical and functional level may be shown). Because of space limitations, the ICD title may consist of key words only.

(f) A legend starting approximately 130 mm (5 inches) below the upper border and ending no closer than 160 mm (6-1/4 inches) to the right-hand border. Special or nonstandard symbols may be added to the legend as required.

(g) Notes to be listed below the legend.

(h) Nonstandard abbreviations to be listed below the notes.

(i) A list of all applicable documents that are referenced or identified in the body of the cable interconnect diagram (except those drawings that are identified on the item number and part identification sheet).

(j) A list of all other applicable documents deemed necessary to define the system configuration baseline, not identified elsewhere in the diagram (e.g., system advanced schematics, electromechanical control diagrams, etc.).

(2) Item Number and Part Identification Sheet. An item number and part identification sheet shall contain the following system component and part identification information in tabular form:

(a) An "Item Number" column shall list the component item number as shown in the diagram. Consecutive item numbers shall be assigned to each component identified. Identical items shall be identified by the same item number and summed quantities shall be identified.

(b) A "Nomenclature" column shall contain either a title or description. Abbreviations may be used due to space limitations. For all items that are not controlled by a Government specification control drawing, detailed descriptive information shall be provided in this column.

(c) The "Drawing Number" column shall contain the component or assembly drawing number plus the suffix. The vendor part number or other stock numbers shall not be shown if the part is assigned a Government specification or drawing number. An approved vendor name and part number shall be provided if the item is not controlled by a Government specification control drawing. In each case, the vendor name and part number shall be followed by the words "or engineering approved equal." Specific, descriptive part information must be given in the "Nomenclature" column.

(d) A "Quantity" column shall contain total quantity of the items and shall be divided as to area of use (e.g., MLP 1, MLP 2, OPF, LCC, etc.).

(3) System Rack Elevation Sheet. A system rack elevation sheet shall be identified by the words RACK ELEVATION directly above the title block and shall show the following:

(a) The system rack elevation by area.

(b) Each element within the rack shall indicate the rack space required (e.g., 170 millimeters, 6.75 inches).

(c) Each element, other than blank panels, shall indicate the reference designator assigned.

(d) Only front elevations shall be shown unless components are normally operated or used with access through rear door.

(4) System Interconnect Diagram Sheet. A system interconnect diagram sheet shall make up the remainder of the cable interconnect diagram and shall show the entire system starting at the hardware interface module. System interconnect diagrams depict the individually controlled elements utilized by the system and are interconnected by cabling to define the relationship between the controlled elements. System interconnect sheets shall be prepared in accordance with the following requirements:

(a) If the controlled element is identified by an approved symbol, the descriptive name of the component is not required. If a block or other symbol is used, a descriptive name shall accompany the symbol. Each controlled element shall be identified by an item number and its assigned reference designator or A-

number. The item number shall be enclosed in a small box and positioned in or near the symbol of the controlled elements and shall be identified by a unique find number or A-number in accordance with section VI of this manual. All electrically or electronically controlled elements shall be identified by a unique reference designator in accordance with section VI of this manual. A-numbers and reference designator numbers shall be obtained from the documentation center for all items presently identified by such a number.

(b) Each electrically controlled element in the system shall be drawn with solid lines.

(c) Cabling that is part of the system shall be drawn with solid lines.

(d) If the assembly outline is shown with the controlled elements, the outline shall be drawn with a heavy solid line.

(e) Dotted or dashed blocks or symbols shall be used to show other systems that interface, and delineation shall always continue to include the first identifiable item past the last solid block and be keyed to other appropriate cable interconnect diagrams (or drawings if no cable interconnect diagram exists). Each dotted or dashed block shall contain the name of the system that is being interfaced, the identification of the first interfaced component or assembly, and the cable interface diagram number of that system.

(f) The size of the component or the weight of the lines shall bear no direct relationship to the size or importance of the function it represents.

(g) All controlled elements in the system shall be shown and identified.

(h) Small details of information shall be added throughout the body of the drawing to improve and enhance the technical usability of the drawings.

(i) Interfaces with 60-hertz power; other special power shall show the circuit breaker number and size.

(j) Phantom lines shall always denote segregation of areas or locations (e.g., rooms, MLP/pad, MLP/VAB). This line shall not be used to separate elements or assemblies unless the elements or assemblies are in different areas or locations.

(k) Cable interconnect diagrams shall be prepared only on drawing format sheets in KSC format (KSC form 21-9) as defined in this manual. The drawing size shall be specified by the responsible design organization.

(l) Lettering templates and/or other mechanical devices shall be used for all drawing text. Lettering in the field of the drawing shall be uppercase Gothic and 3 mm (1/8 inch) high (minimum) for general text and 5 mm (3/16 inch) high (minimum) for headings (e.g., LEGEND, NOTES, ABBREVIATIONS). Electrical connector pin designators usually shown with lowercase letters shall be shown on drawings with underlined uppercase letters. In all cases, lettering shall be large enough to permit reduction to B-size without loss of readability.

(m) Cable interconnect diagram drawing numbers shall be assigned in accordance with the provisions of this manual. Number size shall be 5 mm (3/16 inch) high (minimum).

4.7 MECHANICAL SCHEMATIC

A mechanical schematic defines the function of a fluid circuit, the function and method of operation of each component, and the arrangement and interconnection of the components or elements within one or more fluid systems. (See figure 4-4.) A mechanical schematic shall be required for the fabrication or construction of a fluid valve panel or facility fluid installation involving several fluid systems and shall be used for operation and maintenance.

4.7.1 APPLICATION. A mechanical schematic shall be applicable to all fluid systems: gas, water, hydraulic, air conditioning, oil, fuel, liquefied gas, and vaporized liquid. A mechanical schematic shall be used for fabrication, construction, troubleshooting, reliability analysis, and preparation of operation and maintenance procedures.

4.7.2 REQUIREMENTS. A mechanical schematic shall show the system or equipment from end to end and include all components (operational, control, monitoring, and metering) within that system. Each component shall be identified by a mechanical find number (called an A number), which shall be a unique identifier.

a. The drawing shall show tubing and piping sizes, the medium carried, the direction of the flow, and the normal operating pressure. Maximum allowable working values of pressure and flow, including tolerances may be included if required. Mechanical fluid line codes may be used.

b. Adequate information shall be shown at each electrical interface to allow easy movement from the mechanical schematic to the appropriate electrical schematic. This information shall include minimum overlapping details of components at the interface as well as identification of the electrical drawing by the drawing number.

c. Temperature range shall be indicated if it is other than normal ambient. Relief valve settings, including tolerances, shall be indicated. Instrumentation systems shall be shown and shall include the normal settings (with tolerances) of pressure, temperature, flow, etc., of the instruments.

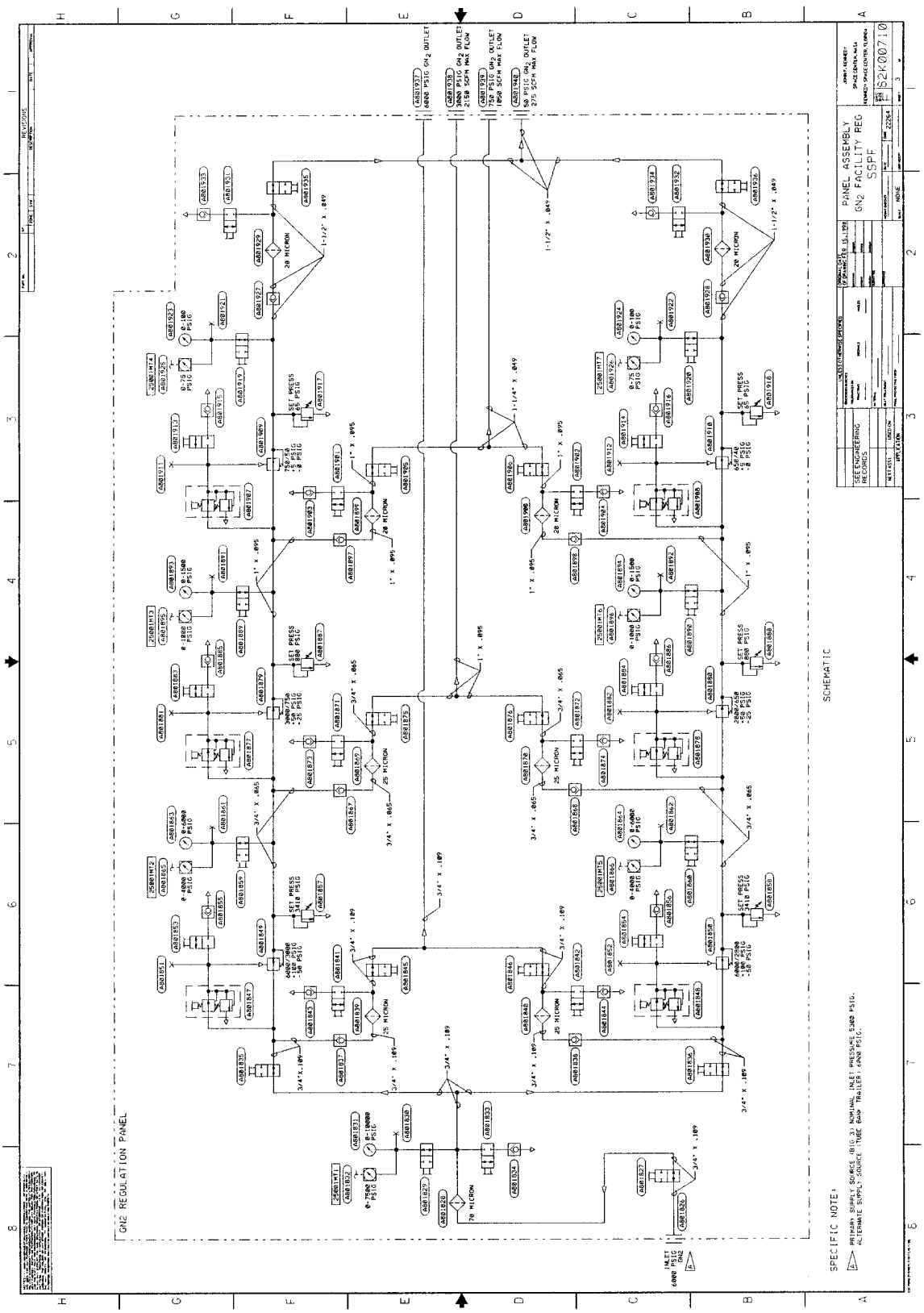


Figure 4-4. Typical Mechanical Schematic

d. Sources of energy (electrical, hydraulic, or pneumatic) to control components (valves, motors, or solenoids) shall be shown.

e. All systems shall be shown in deenergized condition.

f. Flight vehicle interfaces shall be identified by the ICD line number. The ICD's controlling the schematic shall be noted near the title block.

A key area plan shall be included on the drawing near the title block. This plan shall show the approximate location of the system and the interconnection of major components.

4.8 ELECTROMECHANICAL CONTROL DIAGRAM (EMCD)

The electromechanical control diagram depicts end-to-end systems similar to a system mechanical schematic, but may omit passive, inactive, and some manually operated components. (See figure 4-5.) Electrical function designators shall be added to show electrical interfaces.

4.8.1 APPLICATION. Electromechanical drawings shall be used for specified systems in which there are electromechanical devices for understanding and explaining the electromechanically controlled operation of a system. These drawings shall also be used for system analysis, Ground Operations Aerospace Language (GOAL) software programming, failure mode and effects analysis, and hazard analysis.

4.8.2 REQUIREMENTS. An electromechanical control diagram shall show each system from end to end. An end of a system may be a specific interface with another system as a support or service function. Applicable system mechanical schematics and electromechanical control diagrams shall be referenced for the interfacing systems. The active, electromechanically controlled components shall be shown in proper functional relationship, as well as proper logic arrangement, to serve as a basis for understanding system operation from a computer programmer's viewpoint. Function designator numbers shall be shown near related components. Passive and manually operated components may be omitted unless their inclusion is necessary for understanding the system's operation. Components are not restricted to black-box outlines and may appear in the field of the drawing as functionally appropriate.

The following requirements shall also apply to electromechanical control diagrams:

a. Circuits may be omitted where a manually operated switch is open in all supporting operating modes of the system.

b. Flow lines may be omitted where a manually operated valve is closed in all support operating modes of the system (e.g., drain valve lines).

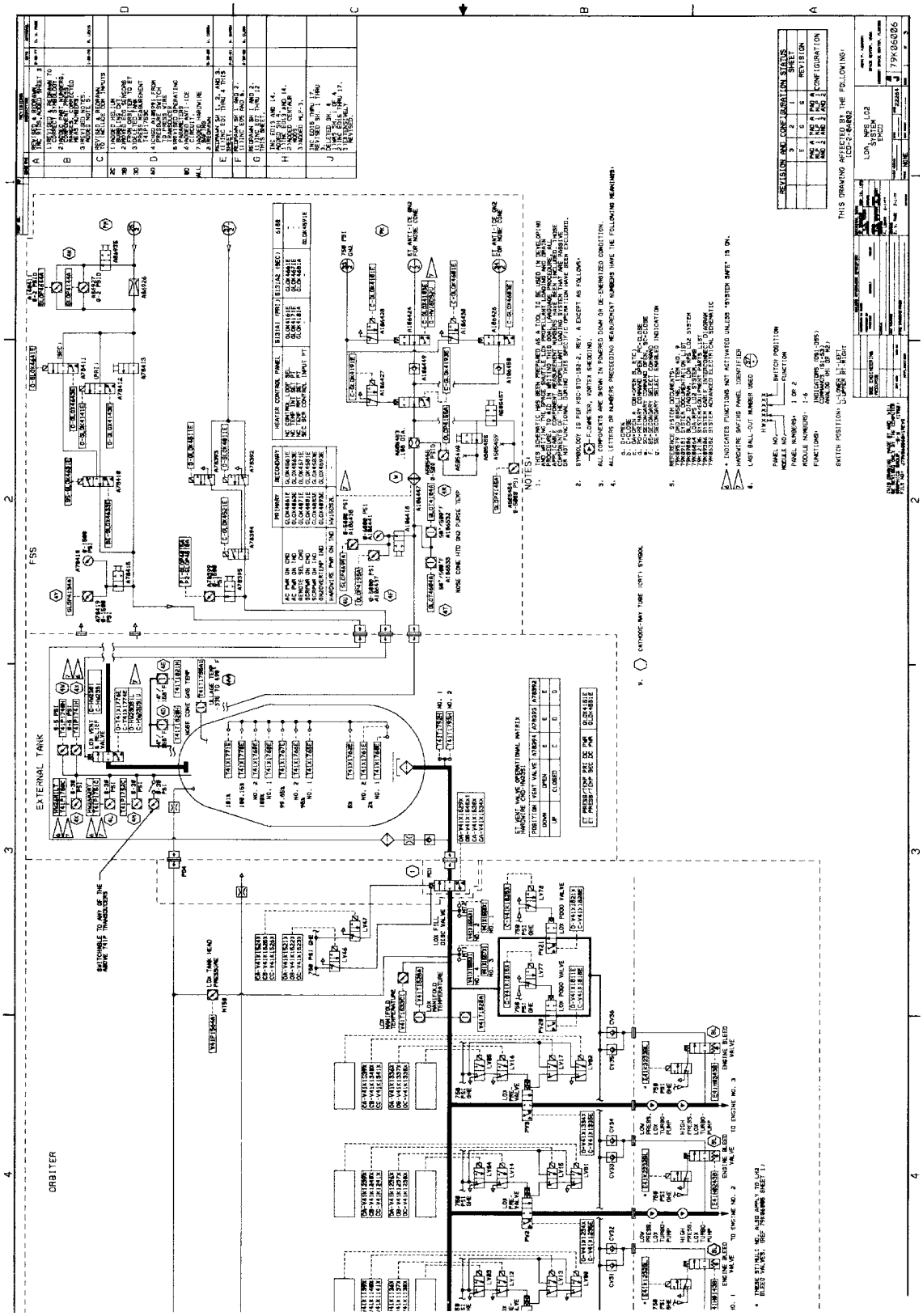


Figure 4-5. Typical Electromechanical Control Diagram

c. Mechanical safety devices may be omitted where either local or remote monitors and alarms on an electromechanical control diagram indicate the result of the safety device operation (e.g., high-pressure relief valves).

d. Manually operated valves that are open in all supporting modes of the system and are not essential to describe system support operation (e.g., isolation valves for risers) may be omitted.

e. All black boxes shall be shown to reflect correct control logic and to complete all flow paths and electrical circuits.

f. Electrical, pneumatic, and pressure-operated switches and valves shall be shown in a deenergized or depressurized position. Where shown, manually operated devices shall be in the normal position for normal system operation. Device position is not shown for redundant and emergency operating modes.

g. The diagrams shall include every subsystem and system indicating, monitoring, recording, and operational control device for all operating modes (e.g., local, remote, automatic, and off). Diagram layout shall be such that bold lines will emphasize the main functional flow of the prime system. The subsystem shall surround this layout to show functional support. An operator valve shall be shown near its related controlled valve (e.g., an electrical solenoid valve near the pneumatically operated main flow valve).

h. Electromechanical drawings for elevator systems or for others with many operating modes and extensive safety features should be prepared to industry standards.

i. Key power diagrams shall be included and shall show the sources of voltages and flow pressures referenced on the diagram. Key layout plans shall be included and shall show the location of end devices and supply systems to be served by the prime system; pickup devices and return system for a closed-loop system; control, monitoring, and sensing devices and elements; and principal equipment.

j. All control, monitoring, and indicating devices in a subsystem shall be shown with related sensors for all operating modes: local, remote, automatic, and manual (including redundancy). Measurement numbers shall be shown.

4.9 SYSTEM MECHANICAL SCHEMATIC (SMS)

A system mechanical schematic is a simplified mechanical schematic showing the arrangement and interconnection of components within a single system. A system mechanical schematic shall not be required for fabrication or construction of the system but shall be needed to operate and maintain the system. The system mechanical schematic may be combined with the electromechanical control diagram.

4.9.1 APPLICATION. A system mechanical schematic shall be used for all applications that pertain to mechanical systems that interface with a space vehicle. (See figure 4-6.)

4.9.2 REQUIREMENTS. A system mechanical schematic shall show all the system end-to-end and mechanical components within the system. All mechanical find numbers shall be shown and the space vehicle shown. Vehicle interfaces shall be identified by the ICD line number. Applicable interface control drawing numbers shall be included. The main system flow may be emphasized by heavy lines. All mechanical components shall be shown in the deenergized position.

4.10 SYSTEM BLOCK DIAGRAM (BD)

A system block diagram is a single-line diagram depicting interconnections and flow between elements of a system or assembly.

4.10.1 DEFINITIONS.

a. Dedicated Element or Assembly. A dedicated element or assembly is the lowest element or assembly to be defined on the system block diagram. These items are essential to the function, flow, and operation of the system and are identified by part number, mechanical find number, and/or reference designator numbers in accordance with this manual.

b. Interface Element or Assembly. An interface element or assembly is an element not dedicated to the system but that interfaces with the system.

4.10.2 APPLICATION. A system block diagram shall be used to provide an end-to-end system management overview to support vehicle operations. (See figure 4-7.)

4.10.3 REQUIREMENTS. The following requirements shall be applicable for the preparation of a system block diagram:

a. The system shall be laid out from left to right where possible (e.g., storage area on the left, vehicle on the right).

b. The fluid flow shall be horizontal where possible (e.g., supply to the right, return to left).

c. The electrical flow shall be from top to bottom where possible.

d. Dedicated elements shall be solid boxes.

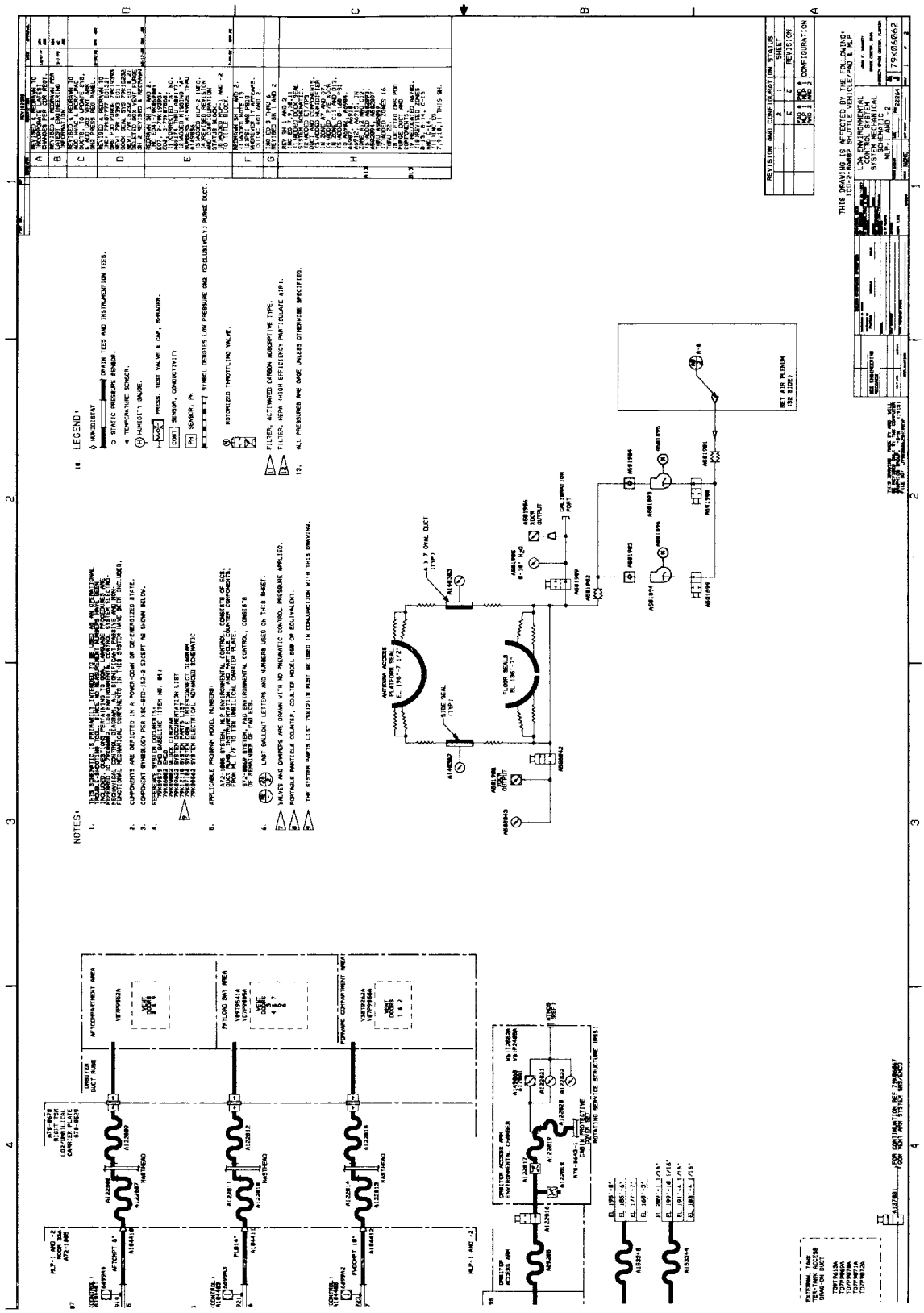


Figure 4-6. Typical System Mechanical Schematic

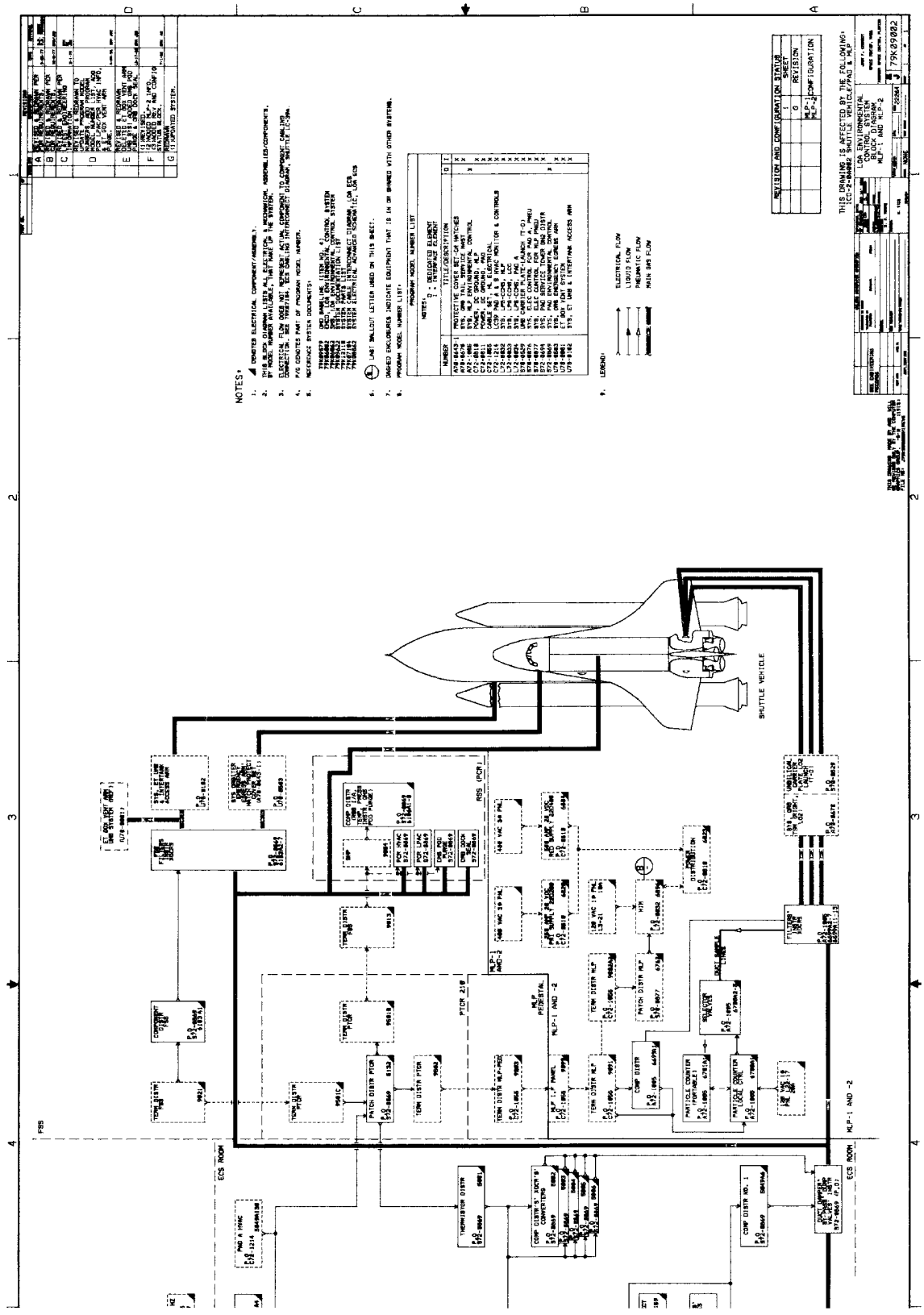
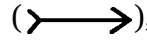


Figure 4-7. Typical System Block Diagram

e. Interfacing elements shall be dashed boxes. Interfacing system block diagrams, if possible, shall be referenced and program and KSC level (II and III) interface control documents shall be referenced at the interface line.

f. Secondary flow direction shall be indicated by arrows, open for electrical (), unfilled for gas (), and filled for liquid ().

g. Main liquid flows may be heavy lines with interior arrows spaced periodically along the pipe, unfilled for gas () and filled () for liquid.

h. The electrical flow shall be light lines with arrows at each end of the cables.

i. The program model number, element title, and schematic and reference designator numbers shall be identified in each block, as applicable.

j. Locations of elements shall be defined (e.g., OPF, MLP, etc.).

k. The title block shall indicate the operations area and system depicted.

1. General notes shall be placed in the upper right side.

m. The drawing shall be structured to place system components in the same relative location as the actual equipment to the maximum degree possible.

n. Drawing numbers for system block diagrams shall be preassigned.

o. System block diagrams may be on J-size format and shall be legible when reduced to B size.

p. Each preparer shall prepare and maintain a list of source data utilized in preparing the system block diagrams. The source data used shall be packaged and filed by system for future reference.

4.11 GROUND INTEGRATED SCHEMATIC (GIS)

A ground integrated schematic combines a system block diagram with its related advanced electrical schematic, cable interconnect diagram, and system mechanical schematic/electromechanical control diagram.

4.11.1 APPLICATION. A ground integrated schematic shall give end-to-end system visibility and definition in various levels of detail and display formats. Used in conjunction with interfacing schematics, a ground integrated schematic is an analytic tool for program engineering and

operational functions. A ground integrated schematic can be used as an aid for preparing operation and maintenance instructions, troubleshooting, fault isolation, and GOAL programming.

4.11.2 REQUIREMENTS. The requirements for a ground integrated schematic shall be the same as the requirements for the individual drawings that make up the schematic. However, a system mechanical schematic/electromechanical control diagram is not required for an electrical system that contains no mechanical components.

4.12 LOGIC DIAGRAM

A logic diagram describes, by means of standard logic symbols and supplementary notations, the details of signal flow and control existing in two-state (binary) devices or portions thereof. A logic diagram may, but does not necessarily, indicate the point-to-point connections that exist in a network of logic elements. There are two types of logic diagrams, basic and detailed.

4.12.1 APPLICATION. A logic diagram shall be applicable to all systems, assemblies, controls, or portions thereof that employ two-state (binary) devices. These diagrams shall be used for design, fabrication, troubleshooting, operation and maintenance, reliability analysis, and modification analysis.

4.12.2 REQUIREMENTS.

4.12.2.1 Basic Logic Diagram. A basic logic diagram shall depict logic functions without reference to physical implementation. It shall contain a minimum amount of detail and shall primarily employ logic symbols to depict logic relationships. Normally, nonlogic functions shall not be shown. Notations shall be included as necessary to produce a complete understanding of the logic design.

4.12.2.2 Detailed Logic Diagram. A detailed logic diagram shall depict all logic functions and show nonlogic functions, socket locations, pin numbers, test points, and other physical elements necessary to describe the physical and electrical aspects of the logic functions.

4.13 FUNCTIONAL FLOW DIAGRAM

A functional flow diagram is an orderly representation of a process. It is a graphic illustration in which activities are defined and their relationships are illustrated by means of symbols that represent operations, data flow, and equipment.

4.13.1 APPLICATION. A functional flow diagram shall be primarily used to develop computer programs but can be used in the analysis of any problem.

4.13.2 REQUIREMENTS. A functional flow diagram shall consist of a set of geometric symbols, each representing a certain operation, and a line indicating the order in which the operations

are to be performed. The basic symbols consist of a diamond representing a yes or no decision; a circle used for starting points, end points, and references to other pages of the flow chart; and rectangles representing specific tasks to be performed.

4.14 SPECIFICATION DRAWINGS

Specification drawings that are utilized for construction, fabrication, modification, or installation of equipment may be prepared in accordance with the NASA specifications kept intact (SPECSINTACT) guidelines and format. Equipment and component procurement/performance, process, and material specification drawings shall be prepared in accordance with the requirements specified in the following paragraphs.

4.14.1 EQUIPMENT PROCUREMENT/PERFORMANCE SPECIFICATION DRAWING. A system or equipment procurement/performance specification is an engineering drawing that establishes the function, performance, and design requirements for maintainability, safety, reliability, and quality assurance to the extent necessary to procure equipment on the commercial market.

4.14.1.1 Application. Equipment specifications are applicable to the procurement of hardware when it is more cost effective for a commercial manufacturer to design and build a piece of equipment than for KSC to design and commercially procure it.

4.14.1.2 Requirements. Equipment procurement/performance specification drawings shall be prepared in accordance with the drawing format specified in this document. The contents of the specifications shall be in accordance with MIL-STD-961.

4.14.2 COMPONENT PROCUREMENT/PERFORMANCE SPECIFICATION DRAWING. A component procurement/performance specification drawing specifies the configuration, performance, test requirements, weight and space limitations, and pipe and cable attachments to the extent necessary to obtain a component on the commercial market.

4.14.2.1 Application. Component procurement/performance specifications are applicable to the procurement of components used in highly critical ground support equipment applications where the natural or induced environment is severe.

4.14.2.2 Requirements. Component specification drawings shall be prepared in accordance with KSC-STD-P-0002.

4.14.3 PROCESS SPECIFICATION DRAWING. A process specification drawing is an engineering drawing that specifies the methods or techniques required to transform materials into a finished product.

4.14.3.1 Application. Process specifications are applicable to fabrication methods or techniques where there is a need to ensure proven procedures, to speed production, to lower costs, and to maintain high quality.

4.14.3.2 Requirements. Process specification drawings shall be prepared in accordance with the drawing format specified in this document. The contents of the specifications shall be in accordance with MIL-STD-961.

4.14.4 MATERIAL SPECIFICATION DRAWING. A material specification drawing is an engineering drawing that establishes the requirements for quality, formulation, properties, safety, and tests or inspections required to procure material.

4.14.4.1 Application. Material specifications are applicable to those applications where industry, Federal, military, or NASA specifications for the material to be procured do not exist or when these specifications do not adequately define, control, or document the material.

4.14.4.2 Requirements. Material specifications shall be prepared in accordance with the drawing format specified in this document. The contents of the specifications shall be in accordance with MIL-STD-961.

4.15 COMPONENT MAINTENANCE DRAWING

A component maintenance drawing depicts all information required for performing component maintenance overhaul and testing.

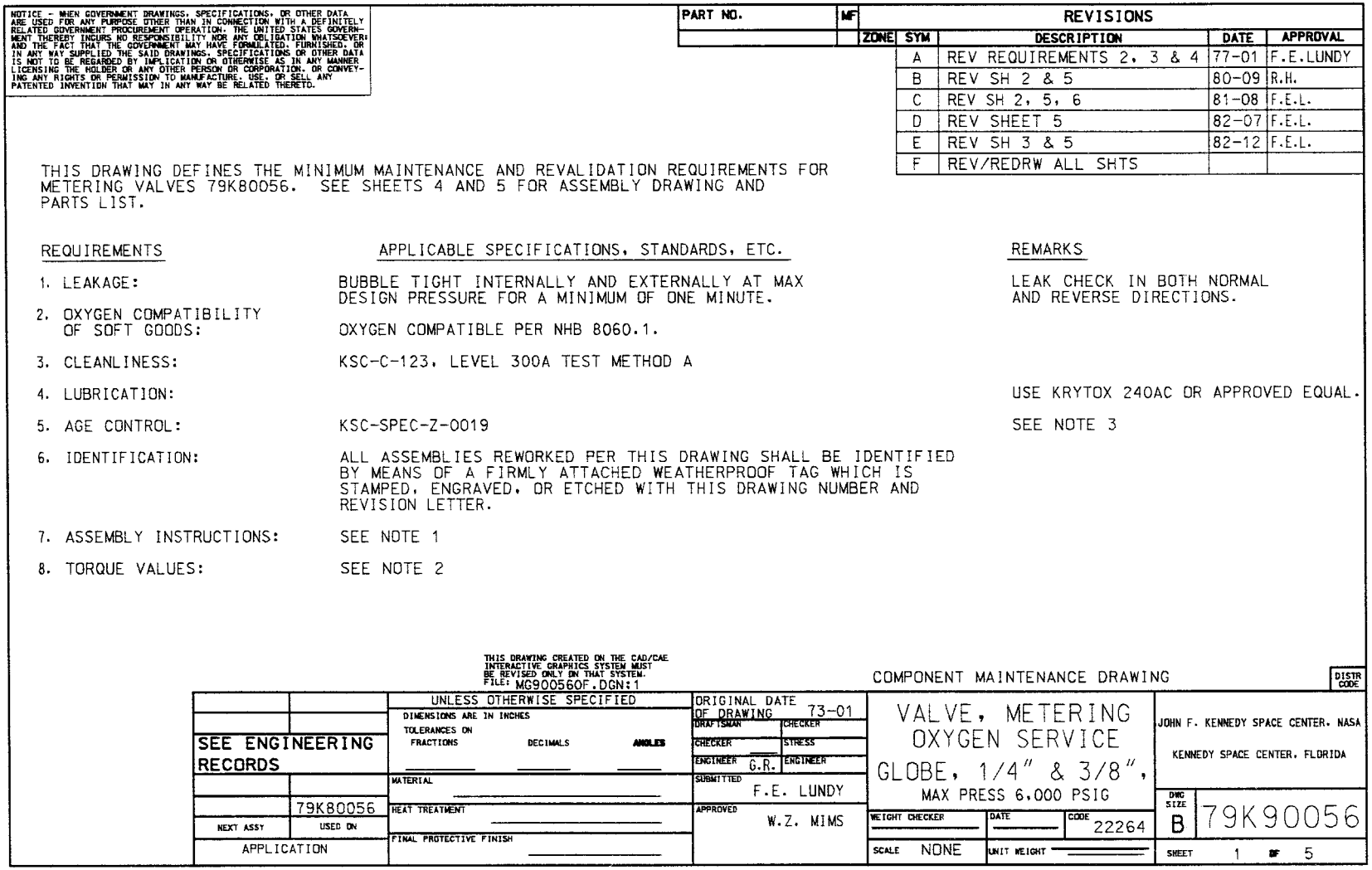
4.15.1 APPLICATION. A component maintenance drawing shall be applicable to all those components defined by KSC specification control drawings that require intermediate and depot maintenance.

4.15.2 REQUIREMENTS. A component maintenance drawing shall include the requirements for adjustment, lubrication, cleaning, torque, fluid compatibility, allowable leakage, special tools, performance parameters, test setups, finishes and coatings, assembly cautions, and design operating pressures. These drawings shall be assembly and section drawings with a complete illustrated parts breakdown. (See figure 4-8.) A component maintenance drawing shall include a parts list. This list is a tabulation of items required to fabricate or assemble the end item to which it applies. The list shall contain the following information:

a. Description: name of part and, when necessary, the size, dimensions, material, and tolerances

b. True manufacturer's name and CAGE number

c. True manufacturer's part number: Government standard part number, if applicable



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PART NO. | MF

REVISIONS

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
	A	REV REQUIREMENTS 2, 3 & 4	77-01	F.E.LUNDY
	B	REV SH 2 & 5	80-09	R.H.
	C	REV SH 2, 5, 6	81-08	F.E.L.
	D	REV SHEET 5	82-07	F.E.L.
	E	REV SH 3 & 5	82-12	F.E.L.
	F	REV/REDRW ALL SHTS		

THIS DRAWING DEFINES THE MINIMUM MAINTENANCE AND REVALIDATION REQUIREMENTS FOR METERING VALVES 79K80056. SEE SHEETS 4 AND 5 FOR ASSEMBLY DRAWING AND PARTS LIST.

REQUIREMENTS	APPLICABLE SPECIFICATIONS, STANDARDS, ETC.	REMARKS
1. LEAKAGE:	BUBBLE TIGHT INTERNALLY AND EXTERNALLY AT MAX DESIGN PRESSURE FOR A MINIMUM OF ONE MINUTE.	LEAK CHECK IN BOTH NORMAL AND REVERSE DIRECTIONS.
2. OXYGEN COMPATIBILITY OF SOFT GOODS:	OXYGEN COMPATIBLE PER NHB 8060.1.	
3. CLEANLINESS:	KSC-C-123, LEVEL 300A TEST METHOD A	
4. LUBRICATION:		USE KRYTOX 240AC OR APPROVED EQUAL.
5. AGE CONTROL:	KSC-SPEC-Z-0019	SEE NOTE 3
6. IDENTIFICATION:	ALL ASSEMBLIES REWORKED PER THIS DRAWING SHALL BE IDENTIFIED BY MEANS OF A FIRMLY ATTACHED WEATHERPROOF TAG WHICH IS STAMPED, ENGRAVED, OR ETCHED WITH THIS DRAWING NUMBER AND REVISION LETTER.	
7. ASSEMBLY INSTRUCTIONS:	SEE NOTE 1	
8. TORQUE VALUES:	SEE NOTE 2	

THIS DRAWING CREATED ON THE CAD/CAE INTERACTIVE GRAPHICS SYSTEM MUST BE REVISED ONLY ON THAT SYSTEM.
FILE: MG900560F.DGN:1

COMPONENT MAINTENANCE DRAWING

DISTR CODE

SEE ENGINEERING RECORDS

NEXT ASSY: 79K80056 | USED ON: APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES

MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 73-01
DRAFTSMAN | CHECKER
CHECKER | STRESS
ENGINEER G.R. | ENGINEER
SUBMITTED F.E. LUNDY
APPROVED W.Z. MIMS

VALVE, METERING
OXYGEN SERVICE
GLOBE, 1/4" & 3/8",
MAX PRESS 6,000 PSIG

WEIGHT CHECKER | DATE | CODE 22264
SCALE NONE | UNIT WEIGHT

JOHN F. KENNEDY SPACE CENTER, NASA
KENNEDY SPACE CENTER, FLORIDA

DWG SIZE B | 79K90056

SHEET 1 OF 5

Figure 4-8. Typical Component Maintenance Drawing (Sheet 1 of 5)

CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
F	REV & REDRAWN		

NOTES:

1. SPARINGLY APPLY KRYTOX 240AC OR EQUAL LUBRICANT ON O-RING SURFACE, THREADED PORTIONS OF ITEMS 1, 5, 9 (EXTERNAL) & 12 BEFORE ASSEMBLY.

2. TORQUE VALUES: ITEM 1, 35-39 FT LBS
   ITEM 9, 35-39 FT LBS
   ITEM 12, 25-35 IN LBS

3. ASSEMBLY DATE MARKING IN ACCORDANCE WITH KSC-SPEC-Z-0019 IS REQUIRED FOR AGE CONTROL OF ELASTOMERIC PARTS.

4 VENDOR IS TESCOM CORPORATION.

5 THIS ITEM IS PART OF INTERNAL SOFT GOODS KIT, VENDOR PART NO. 389-1569.

6 BATCH TEST REQUIRED PER DWG 79K19956.

THIS DRAWING CREATED ON THE CAD/CAE INTERACTIVE GRAPHICS SYSTEM MUST BE REVISED ONLY ON THAT SYSTEM.
FILE: MG90056F.DGN;1

CODE IDENT NO	DWG SIZE	79K90056
22264	B	SHEET 2

Figure 4-8. Typical Component Maintenance Drawing (Sheet 2 of 5)

CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
F	REV & REDRAWN		

KSC PART NUMBER	VENDOR PART NUMBER	INLET & OUTLET PORTS	DESIGN PRESSURE PSIG MAX	REPAIR KIT VENDOR PART NUMBER
79K80056-1	30-1111-304-180	MS33649-4	6000	389-1569
79K80056-2	30-1111-306-180	MS33649-6	6000	389-1569

THIS DRAWING CREATED ON THE CAD/CAE INTERACTIVE GRAPHICS SYSTEM MUST BE REVISED ONLY ON THAT SYSTEM.
FILE: MG900560F.DGN;1

CODE IDENT NO	DWG SIZE	79K90056
22264	B	SHEET 3

Figure 4-8. Typical Component Maintenance Drawing (Sheet 3 of 5)

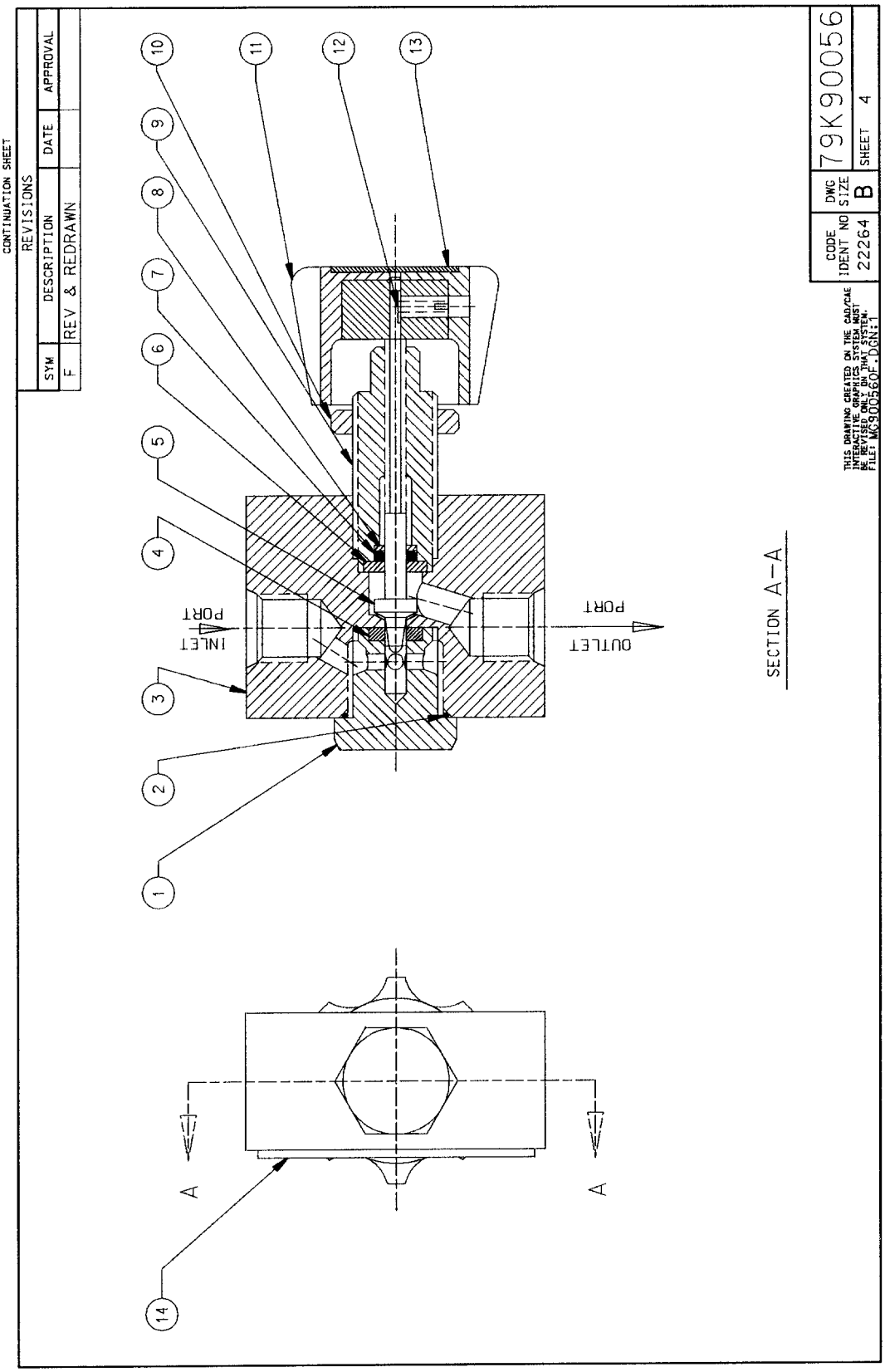
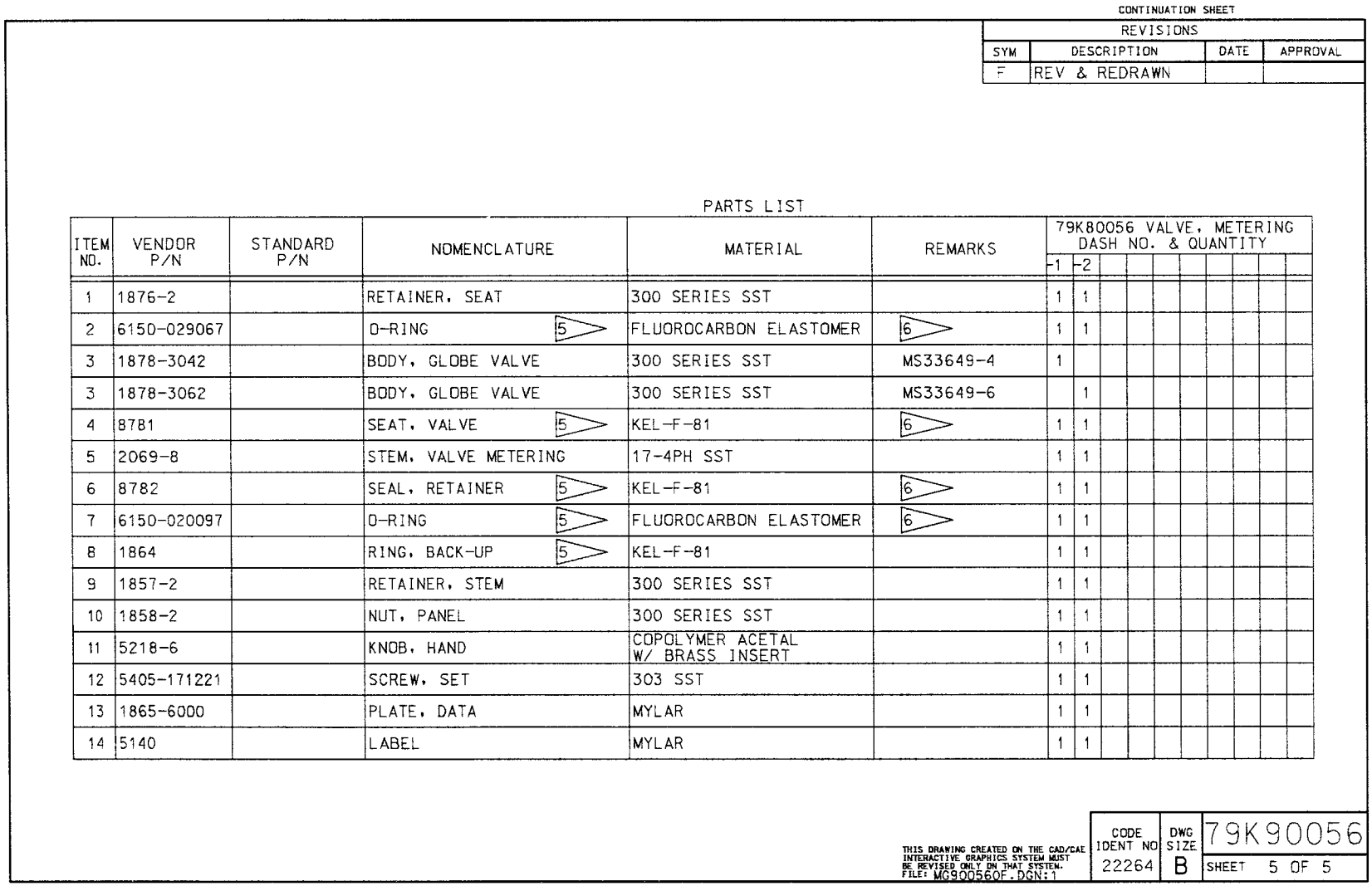


Figure 4-8. Typical Component Maintenance Drawing (Sheet 4 of 5)



CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
F	REV & REDRAWN		

PARTS LIST

ITEM NO.	VENDOR P/N	STANDARD P/N	NOMENCLATURE	MATERIAL	REMARKS	79K80056 VALVE, METERING DASH NO. & QUANTITY -1	-2
1	1876-2		RETAINER, SEAT	300 SERIES SST		1	1
2	6150-029067		O-RING 5	FLUOROCARBON ELASTOMER	6	1	1
3	1878-3042		BODY, GLOBE VALVE	300 SERIES SST	MS33649-4	1	
3	1878-3062		BODY, GLOBE VALVE	300 SERIES SST	MS33649-6		1
4	8781		SEAT, VALVE 5	KEL-F-81	6	1	1
5	2069-8		STEM, VALVE METERING	17-4PH SST		1	1
6	8782		SEAL, RETAINER 5	KEL-F-81	6	1	1
7	6150-020097		O-RING 5	FLUOROCARBON ELASTOMER	6	1	1
8	1864		RING, BACK-UP 5	KEL-F-81		1	1
9	1857-2		RETAINER, STEM	300 SERIES SST		1	1
10	1858-2		NUT, PANEL	300 SERIES SST		1	1
11	5218-6		KNOB, HAND	COPOLYMER ACETAL W/ BRASS INSERT		1	1
12	5405-171221		SCREW, SET	303 SST		1	1
13	1865-6000		PLATE, DATA	MYLAR		1	1
14	5140		LABEL	MYLAR		1	1

THIS DRAWING CREATED ON THE CAD/CAE INTERACTIVE GRAPHICS SYSTEM MUST BE REVISED ONLY ON THAT SYSTEM.
FILE: MG900560F.DGN;1

CODE IDENT NO	DWG SIZE	79K90056
22264	B	SHEET 5 OF 5

Figure 4-8. Typical Component Maintenance Drawing (Sheet 5 of 5)

d. Repair parts: when repair parts are supplied in the form of kits or as quick-change units, they shall be identified.

e. Quantity: quantity of each part required

4.16 CABLE HARNESS DRAWING

A cable harness (or wire harness) drawing defines a group of wires fabricated in advance of the final assembly in a specified configuration for electrical connection within a unit or assembly. (See figure 4-9.)

4.16.1 APPLICATION. A cable or wire harness drawing shall be used for the fabrication of the internal wiring of an electrical distributor or enclosure.

4.16.2 REQUIREMENTS. A cable harness drawing shall show all dimensions necessary to define the harness form and termination points. A cable harness drawing shall also include a schematic, data markings, color codes, lengths, material specifications, and other data as necessary. Instructions or references thereto for the fabrication of the harness shall be included in the notes.

4.17 CABLE ASSEMBLY DRAWING

A cable assembly drawing is a listing of single or branched cable assemblies and/or wire bundles or harnesses that provides information about the configuration of cables within a piece of ground support equipment or a system.

4.17.1 APPLICATION. A cable assembly drawing is used in conjunction with a cable subassembly drawing and shall be used for the fabrication of a new cable assembly installed in a piece of ground support equipment or a system.

4.17.2 REQUIREMENTS. A cable assembly drawing shall specify part numbers, reference designator numbers, materials, end configurations, and lengths (in meters) in tabular form. A sketch of a typical cable with dimensions and cable markings shall also be included. (See figure 4-10.)

4.18 CABLE INSTALLATION DRAWING

A cable installation drawing shows the installed and assembled position of electrical cable assemblies relative to the supporting structure or to associated items.

4.18.1 APPLICATION. A cable installation drawing shall be used to route, locate, position, attach, and mount electrical cables on ground support equipment.

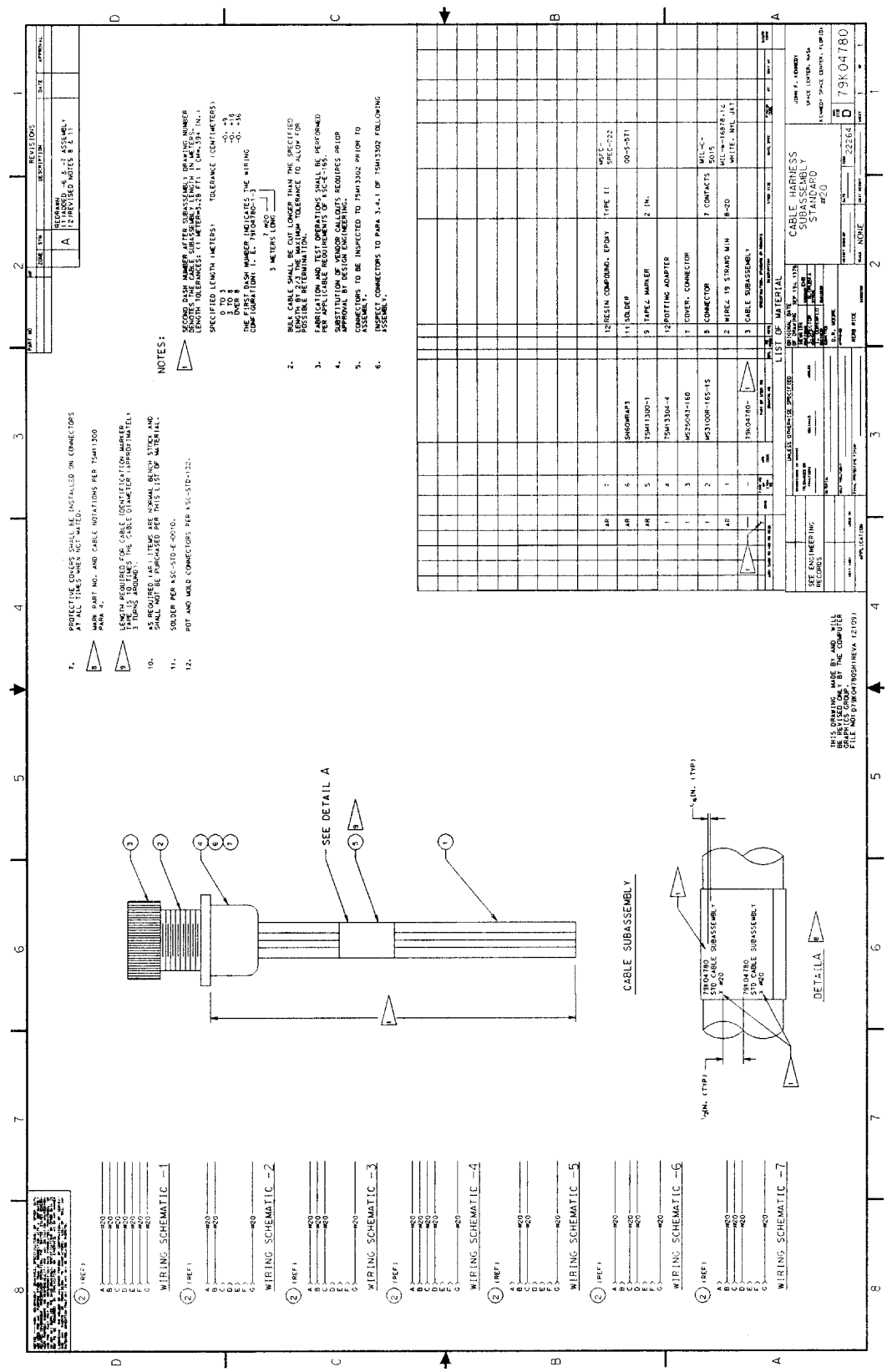


Figure 4-9. Typical Wire Harness Drawing

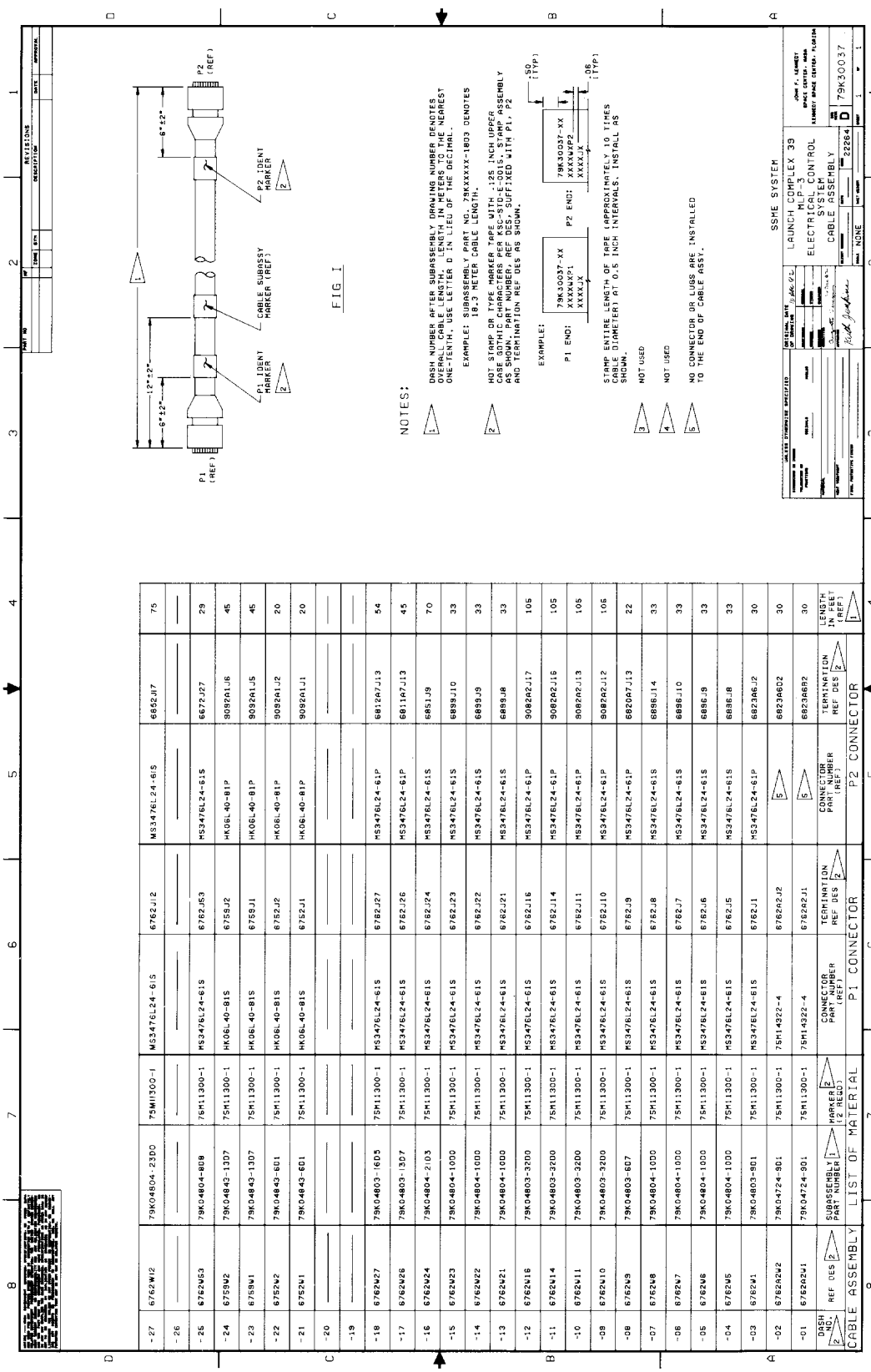


Figure 4-10. Typical Cable Assembly Drawing

4.18.2 REQUIREMENTS. A cable installation drawing shall show adequate information to identify electrical cables, mating connectors, terminations, and critical clearances or support points. Information necessary for lacing, taping, protective coating, electrical bonding, etc., shall be specified on the drawing or by reference to applicable documents. (See figure 4-11.)

4.19 CABLE SUBASSEMBLY DRAWING

A cable subassembly drawing is a drawing that provides information about the characteristics of a cable assembly and/or harness. Each subassembly is a standard item and may be used on many cable assembly drawings.

4.19.1 APPLICATION. Used in conjunction with a cable assembly drawing, a cable subassembly drawing shall be used for the fabrication of new cables and/or harness assemblies. (See figure 4-12.)

4.19.2 REQUIREMENTS. A cable subassembly drawing is a drawing that shall specify cables, connectors, accessories, wiring schematic, and fabrication instructions that are required to build a cable assembly and/or harness assembly. Length of cable and marking information are contained in the cable assembly drawing.

4.20 PRINTED-WIRING DRAWING

A printed-wiring drawing depicts the size, shape, pattern, parts, and components applicable to the design of printed circuit wiring and printed circuit boards. The drawings shall meet or exceed the documentation requirements of ANSI/IPC-D-325. These drawings are of the following types:

4.20.1 PRINTED-WIRING ASSEMBLY DRAWING.

4.20.1.1 Application. A printed-wiring assembly drawing shall depict the printed-wiring board to which separately manufactured parts, components, or materials have been added.

4.20.1.2 Requirements. A printed-wiring assembly drawing shall establish the size and shape of the printed-wiring board, the size and location of all the holes therein, marking materials, components, and the conductor definition. (See figure 4-13.) The assembly drawing shall include, as a minimum, the following:

a. A parts list

b. Assembly detail

c. Printed-wiring board detail

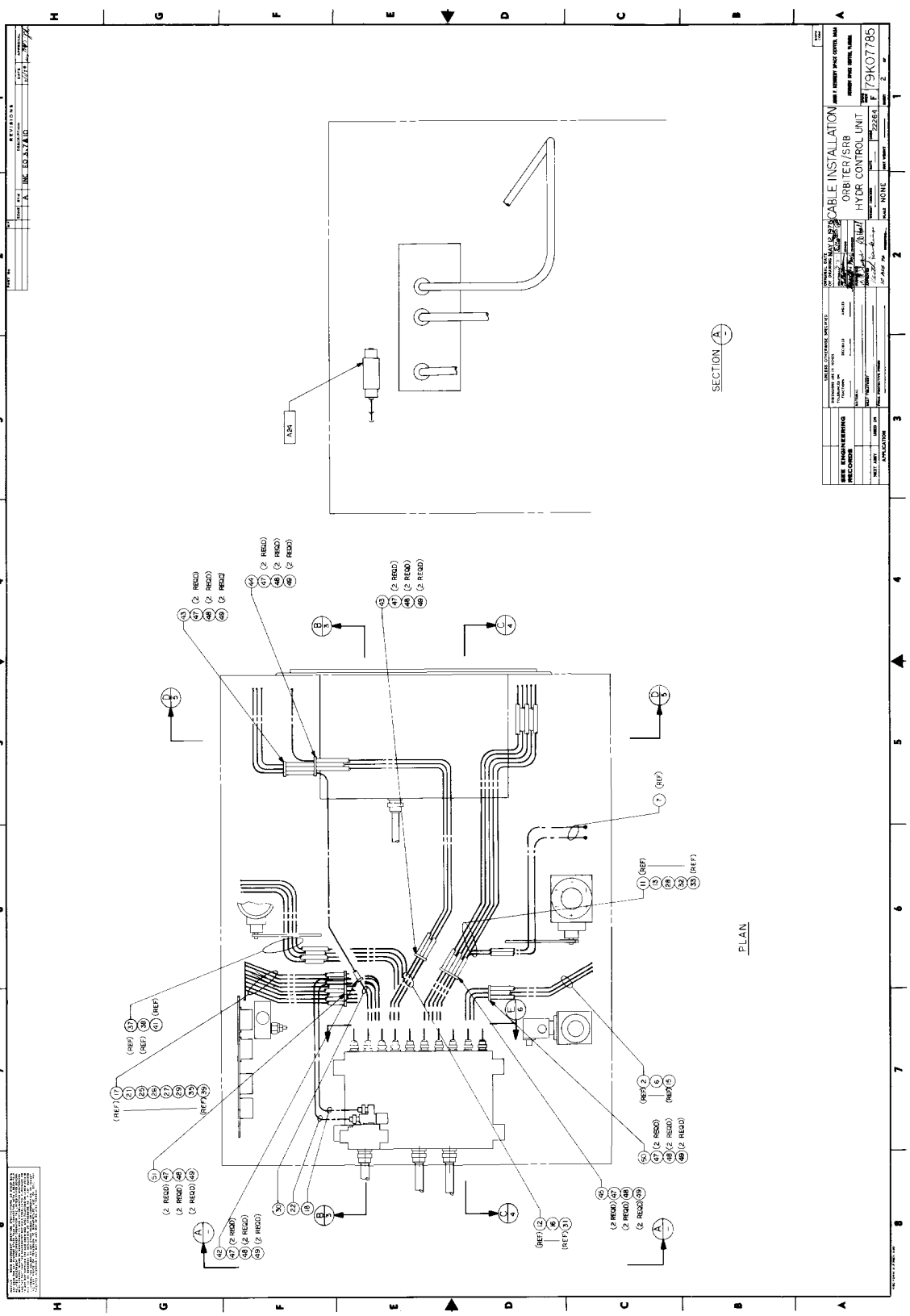


Figure 4-11. Typical Cable Installation Drawing

FABRICATE PER THIS DRAWING AND THE FOLLOWING INSTRUCTIONS OF 79K19600

1 X	5 X	9	13 X
2	6	10	14
3	7	11	15
4	8	12	16

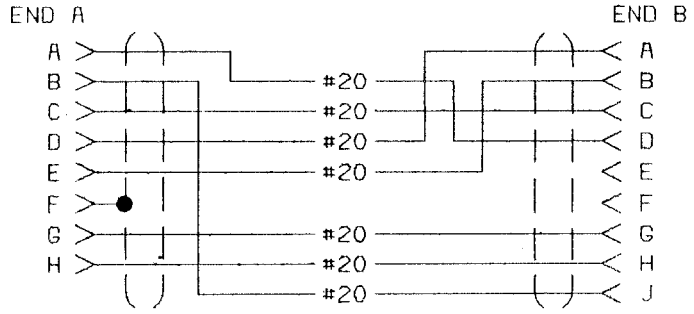
AUTHORIZED SUBSTITUTIONS: S

BENCH STOCK MATERIALS
(See general requirements of 79K19600)

- X SOLDER SN60WRAP3, QQ-S-571
- ___ WIRE,B , 19 STRAND, MIL-W-16878/1
- ___ TAPE, POLYESTER, TYPE 1, L-T-100, 3/4 IN.
- ___ EPOXY (SEE INSTRUCTION 6)
- ___ POLYURETHANE (SEE INSTRUCTION 7)
- X MARKER TAPE (SEE INSTRUCTION 13)

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL
A	PART NO. CHANGED FROM: MS3723-14R6-8N TO: MS3723-14R16-8N	11/8/90	



FIND NO	DESCRIPTION	PART NUMBER	MFR CODE	NO. REQD	STOCK SIZE	MATL. SPEC	SPL. NOTES
12							
11							
10							
9							
8							
7							
6	BACKSHELL	M83723-15S -16R	1 A				
5	BACKSHELL	M83723-15S -12R	1 B				
4	TAPE, MARKER	7510-00-K02-9754					
3	CONNECTOR	M83723-14R16 -8N	1 A				
2	CONNECTOR	M83723-13R12 -10N	1 B				
1	CABLE	5321	92194	1	0.36 OD		

LIST OF MATERIALS

ORIGINAL DATE OF DRAWING 06-20-90
DRAFTSMAN C. Cobb
ENGINEER/CHECKER D. FAVATA
SYSTEM ENGINEER D. MACKE
APPROVED D. ERI 6-27-90

Do Not Initial Last Name

CABLE SUBASSEMBLY

8(8#20)

JOHN F. KENNEDY SPACE CENTER, NASA
Kennedy Space Center
Florida 32899

DWG SIZE A | 80K53462 | SHEET 1 OF 1

KSC FORM 21-2E (6/92)

Figure 4-12. Cable Subassembly Drawing

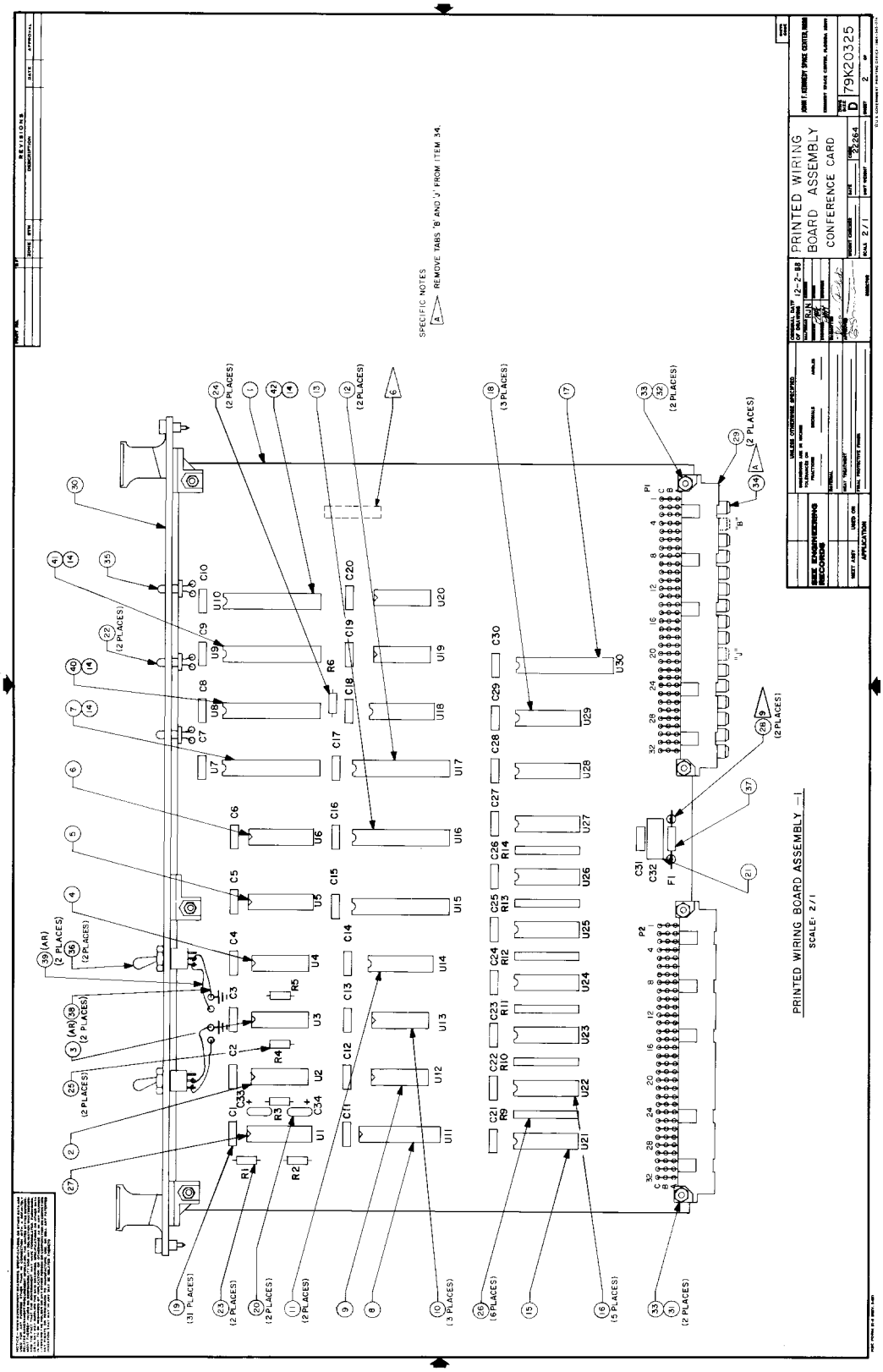


Figure 4-13. Typical Printed-Wiring Assembly Drawing

d. Reference masters

e. Board schematic/logic diagram

4.20.2 PRINTED-WIRING MASTER PATTERN DRAWING.

4.20.2.1 Application. A printed-wiring master pattern drawing is a precise scale pattern that is used to produce the printed circuit within the accuracy requirements of the assembly drawing. (See figure 4-14.)

4.20.2.2 Requirements. A printed-wiring master pattern drawing shall be prepared on a stable base film. The drawing shall not be drawn on a KSC drawing format as required by this manual. The drawing shall contain a board outline, alignment targets, and all printed markings in addition to the conductive and nonconductive paths drawn to precise scale.

4.21 ASSEMBLY DRAWING

An assembly drawing depicts the assembly relationship of two or more parts, a combination of parts and subassemblies, or a group of assemblies.

4.21.1 APPLICATION. An assembly drawing shall be compiled by the responsible KSC engineering organization to aid in the assembly installation. Assembly drawings are generally not maintained drawings, unless operation and maintenance documentation (OMD) requirements specifically require them to be kept updated.

4.21.2 REQUIREMENTS. An assembly drawing shall contain sufficient views to show the relationship between each subassembly and part comprising the assembly depicted. Subassemblies and parts shall be called out in the field of the drawing by find (item) numbers cross-referenced to the identifying numbers in a parts list. The assembly drawing shall show where the revision and dash numbers are to be stamped on the board. When part identification and assembly relationship are shown on subassemblies, unless referenced thereon, this information shall not be repeated on the assembly drawing of the next higher order; only the identifying number, configuration, and location of the subassembly shall be shown. Assembly drawings shall contain references to pertinent installation drawings and wiring and schematic diagrams, as applicable. The division of an assembly into subassemblies shall be in accordance with practical assembly and disassembly procedures. (See figure 4-15.)

4.21.2.1 Electrical Items. Electrical items shall be shown and identified on assembly drawings; however, small electrical items mounted by means of wire connections may be shown and identified either on the assembly drawing or on the pertinent wiring diagram. Wiring diagrams when included in assembly drawings shall show only the wiring for components in the assembly shown. Interconnects with other equipment in system will be covered by reference drawings.

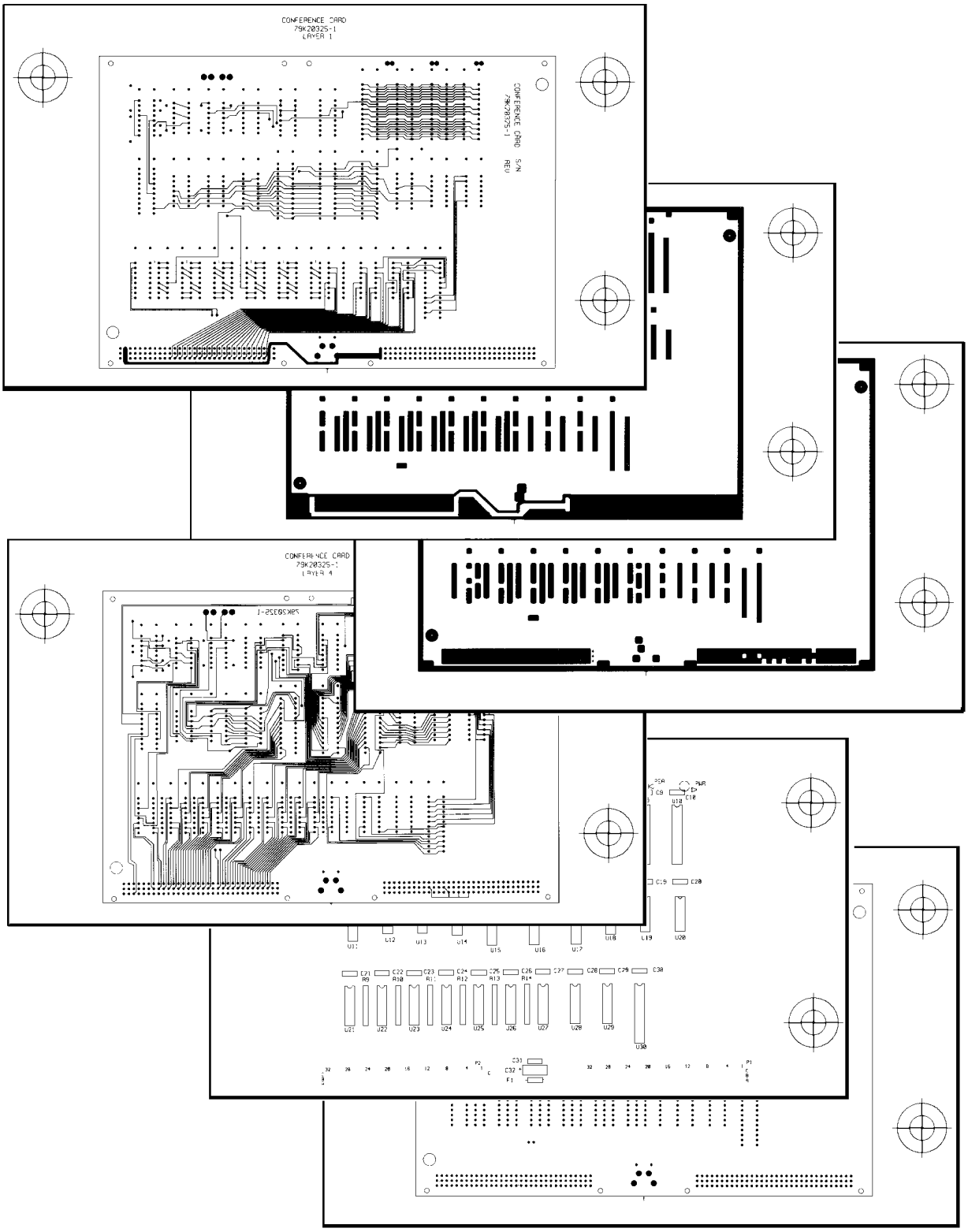


Figure 4-14. Typical Printed-Wiring Master Pattern Drawing

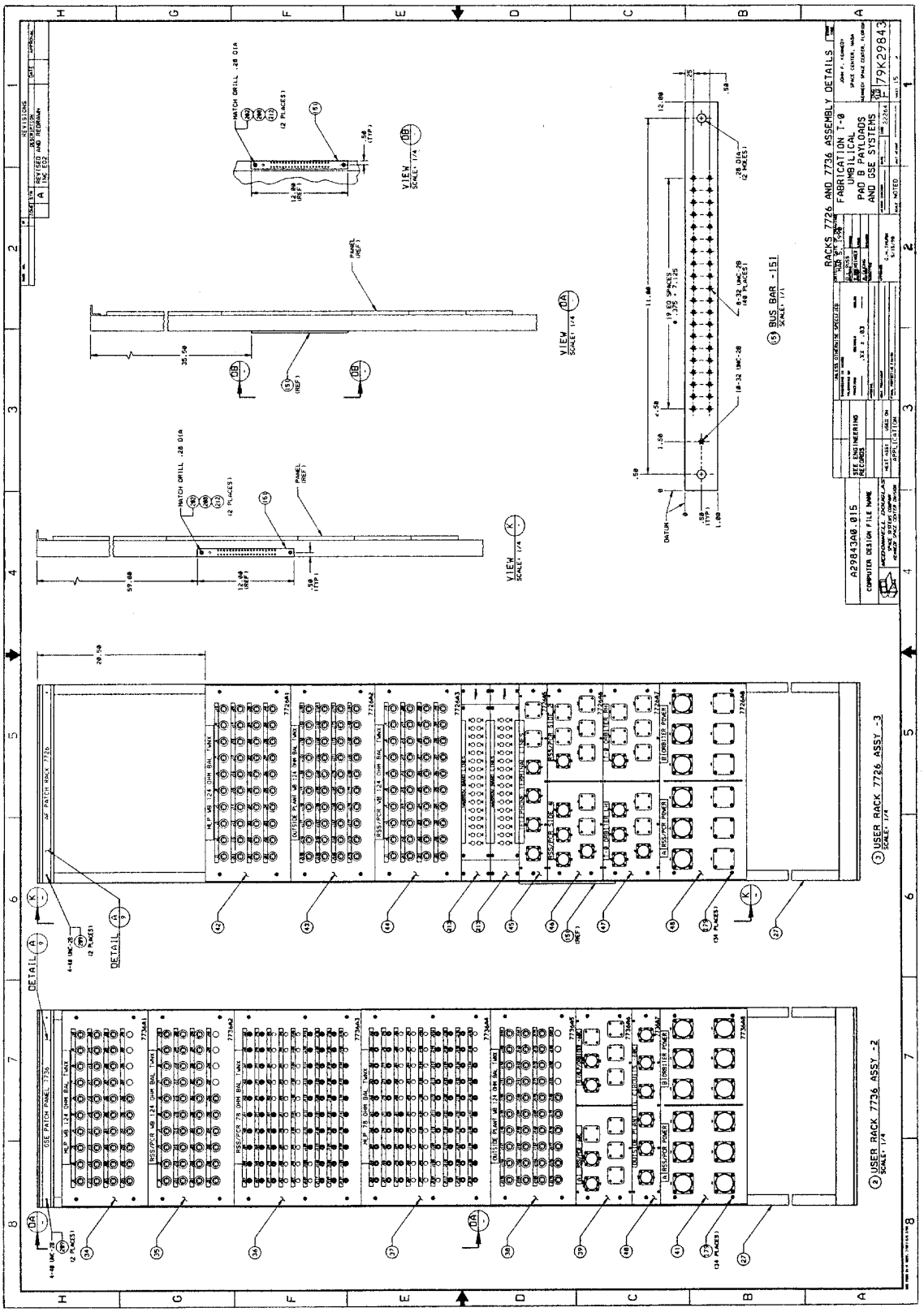


Figure 4-15. Typical Assembly Drawing

4.21.2.2 Attaching Parts. Attaching parts (bolts, nuts, washers, etc.) required to mount and retain assemblies shall be called out on assembly drawings by find (item) numbers showing the item on which the attachment takes place.

4.22 DETAIL ASSEMBLY DRAWING

A detail assembly drawing depicts an assembly on which one or more parts are detailed within the assembly view or auxiliary views, in lieu of preparing separate detail drawings. (See figure 4-16.)

4.22.1 APPLICATION. A detail assembly drawing shall be used to show the relationship between parts common to an assembly with adequate details of the parts for fabrication or purchase.

4.22.2 REQUIREMENTS. A detail assembly drawing shall identify or define all items necessary to complete the assembly and define their assembled relationship. Other requirements shall be those specified for an assembly drawing.

4.23 DETAIL DRAWING

A detail drawing consists of sufficient delineation or description with necessary dimensioning and supporting information to define a part and represents the as-built configuration. (See figure 4-17.)

4.23.1 APPLICATION. A detail drawing shall be used when a part is not a one-time item, is a standard part, or has more than one application.

4.23.2 REQUIREMENTS. A detail drawing shall define all features of the parts depicted, including, as applicable, configuration, dimensions, tolerances, materials, mandatory processes, surface finish, protective coating, symbols, etc. Documents required to supplement the drawing in stating end-product requirements for the part shall be prescribed by notes or tables on the drawing. When a group of similar items has both constant and variable characteristics, these characteristics shall be shown in tabular form to avoid preparing an individual drawing for each item. Detail drawings shall show the next higher drawing numbers. When parts of an item are permanently attached (e.g., a weldment), part numbers shall not be used to define the individual parts (e.g., back plate, gusset, and top plates), but sufficient detail (dimensions and specifications) shall be provided for fabrication and installation.

4.24 ARRANGEMENT DRAWING

An arrangement drawing depicts the relationship of major units of an item in any projection or perspective, with or without controlling dimensions, and represents the as-built configuration.

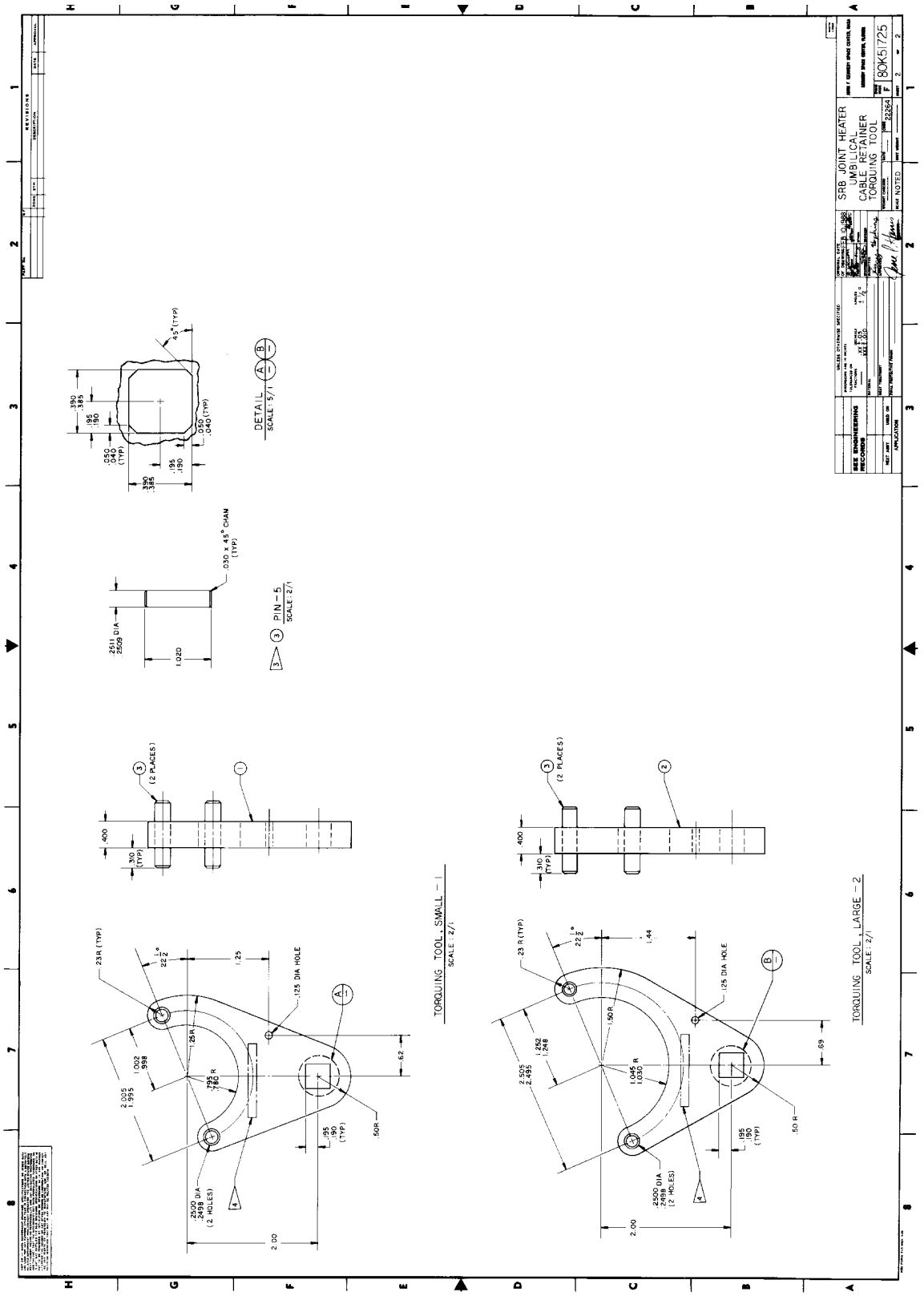


Figure 4-16. Typical Detail Assembly Drawing

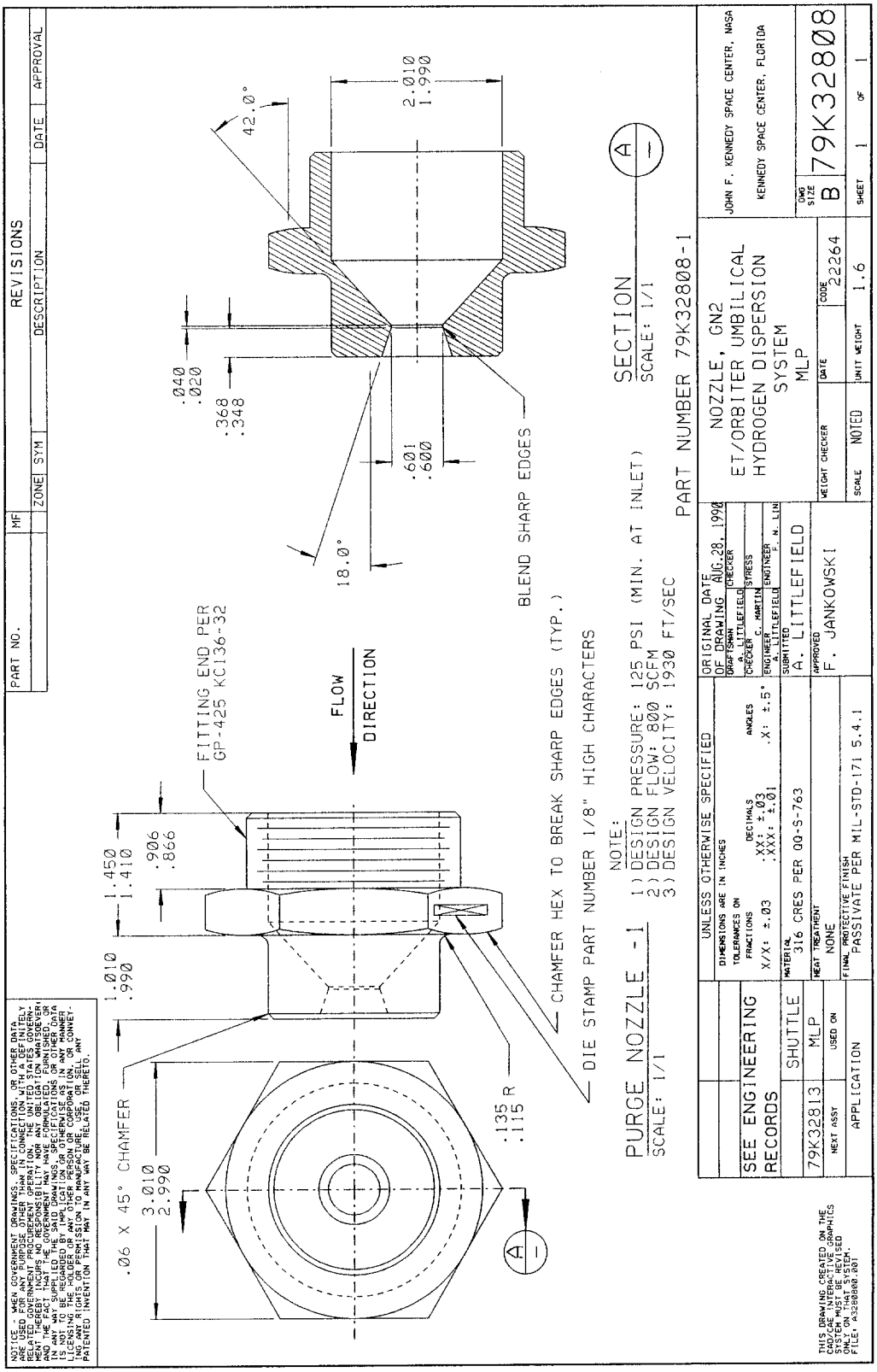


Figure 4-17. Typical Detail Drawing

4.24.1 APPLICATION. An arrangement drawing shall be used to clarify the relationship between assemblies.

4.24.2 REQUIREMENTS. An arrangement drawing shall show sufficient views of the item to convey a general understanding of the configuration and the location of major units. Overall, locating and other general dimensions necessary to define the configuration may be shown. Major units shall be identified.

4.25 ENVELOPE DRAWING

An envelope drawing discloses configuration, performance, and test requirements to the extent necessary to enable development of design details of a new item, and represents the as-built configuration.

4.25.1 APPLICATION. An envelope drawing shall be used to define the space a component uses, without showing complete details.

4.25.2 REQUIREMENTS. An envelope drawing shall depict configuration; mounting and mating dimensions and other necessary dimensions; performance, installation, reliability, and interchangeability characteristics; and test requirements to the extent necessary to develop design details. If an electrical, electronic, or other engineering circuit is involved, a schematic connection or other appropriate diagram shall be included or referenced for information on making external connections.

4.26 INSTALLATION DRAWING

An installation drawing shows general configuration, attaching hardware, and information to locate, position, and install an item relative to its supporting structure or to associated items and represents the as-built configuration. (See figure 4-18.)

4.26.1 APPLICATION. An installation drawing shall be used when a fully assembled item, such as a panel or distributor, is to be installed in a larger unit and may show the miscellaneous attaching hardware, components, and electrical connections.

4.26.2 REQUIREMENTS. An installation drawing shall include the following, as applicable:

a. Interface mounting and mating information such as attaching hardware and its dimensions or locations

b. Interface pipe and cable attachments required when the item is to be installed and to function with related items

c. Information necessary for preparation of foundation plans, including mounting plate details, drilling plans, shock mounting, and buffer details

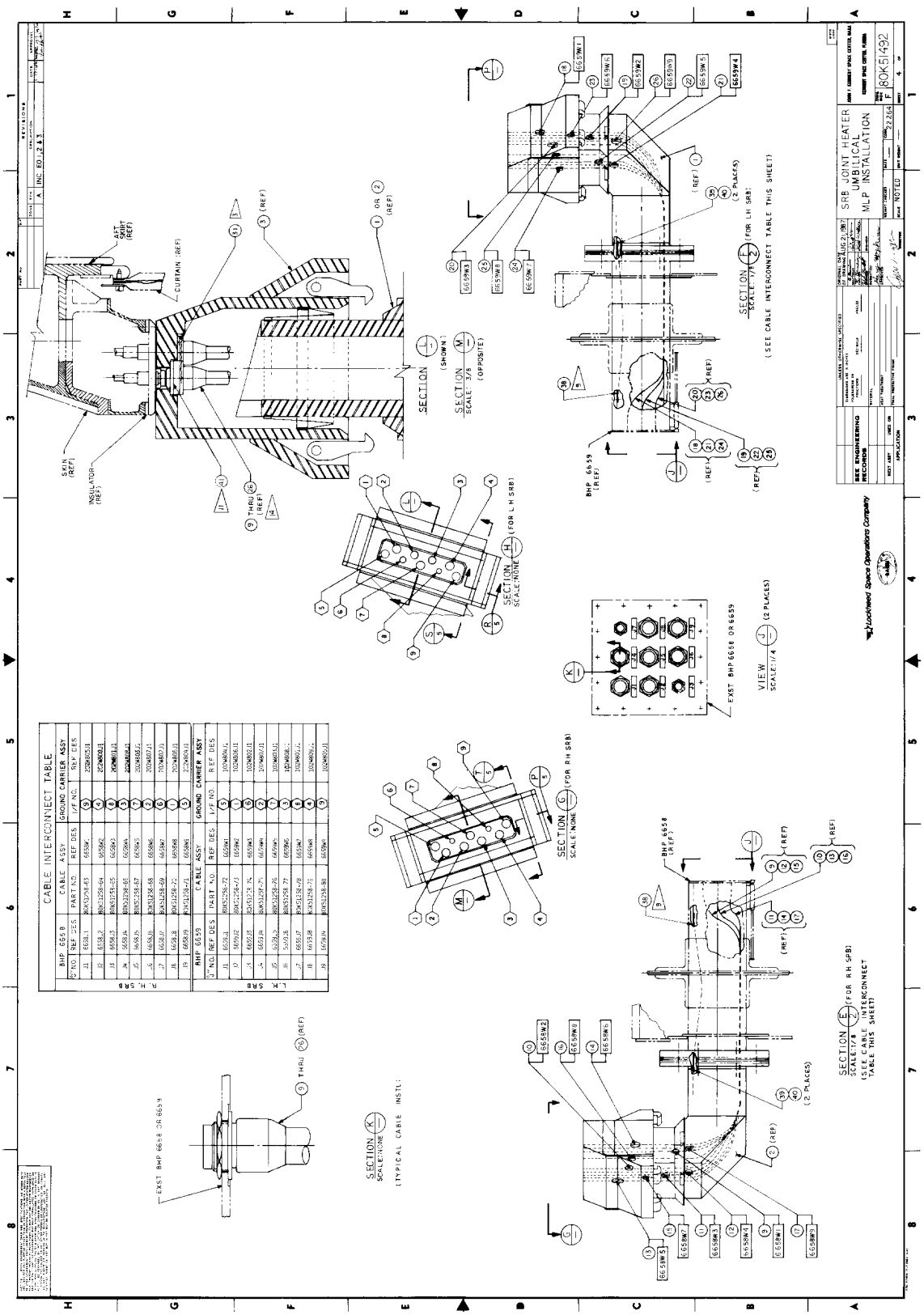


Figure 4-18. Typical Installation Drawing

d. Location, size, and arrangement of ducts

e. Weight of unit

f. Location, type, and dimensions of cable entrances, terminal tubes, and electrical connectors

g. Interconnecting and cable data

h. Overall and principal dimensions in sufficient detail to establish the limits of space in all directions required for installation, operation, and servicing. The amount of clearance required to permit the opening of doors for the removal of plug-in units shall be included. Clearance for travel or rotation of any moving parts shall be shown, including the centers of rotation; angles of train in azimuth, elevation, and depression; and radii from each pivot to the end of each rotating element involved in clearance determination.

4.27 SPACE ALLOCATION DRAWING

A space allocation drawing sets forth dimensional information for an item in terms of area and space, sway and access clearance, and pipe and cable attachment required when the item is to be installed and to function with related items, and represents the as-built configuration.

4.27.1 APPLICATION. A space allocation drawing shall be used to define critical or unusual functional or space requirements within GSE or a facility.

4.27.2 REQUIREMENTS. A space allocation drawing may include overall and principal dimensions in sufficient detail to establish the limits of space in all directions required for installation, operation, and servicing. The amount of clearance required to permit the opening of doors or the removal of plug-in units shall be included. Clearance for travel or rotation of any moving parts shall be shown including the centers of rotation; angles of train in azimuth, elevation, and depression; and radii from each pivot point to the end of each rotating element involved in clearance determination.

4.28 MATCHED-PARTS DRAWING

A matched-parts drawing depicts parts that are machine-matched or otherwise mated and for which assembly or replacement as a matched set or pair is essential.

4.28.1 APPLICATION. A matched-parts drawing shall be used for parts that must be assembled, ordered, or stocked as a set or pair for proper functioning of the equipment (e.g., gears, springs, electronic parts, and bearing housings).

4.28.2 REQUIREMENTS. A matched-parts drawing shall designate each matched set or pair and shall state the operating or mating characteristics that are the primary reasons for the use of matched parts. The individual matched parts may be detailed on the matched-parts drawing, if practical, in lieu of separate detail drawings. However, a single part number, which shall be the number of the matched-parts drawing or shall include the number of the matched-parts drawing, shall be assigned to each matched part. The drawing shall require identification marking on each part. The note FURNISH ONLY AS A MATCHED SET shall be stated on the drawing.

4.29 ALTERED-PART DRAWING

An altered-part drawing depicts an item produced by a manufacturer under the manufacturer's part or catalog number that has been modified for use. (See figure 4-19.)

4.29.1 APPLICATION. An altered-part drawing shall be made only when the item cannot be used as manufactured, and then only when the vendor has rejected a request to make the alteration. A new part identification shall be assigned to the altered item.

4.29.2 REQUIREMENTS. An altered-part drawing shall contain sufficient data to allow procurement of the original item from the same or other source. All alteration information shall be clearly shown in detail and marked with an asterisk (*) to distinguish this information from any other information that may be supplied. The note ALL DIMENSIONS, REQUIREMENTS, ETC., MARKED BY AN ASTERISK (*) ARE ALTERATIONS OF THE ITEMS AS SUPPLIED UNDER THE VENDOR'S IDENTIFICATION NUMBER shall be stated on the drawing. The drawing number shall be the same as the number of the altered item and shall show the vendor's name, address, and part number. However, when identifying the part, the vendor's identification shall be removed and the part reidentified with a number that shall be or shall include the drawing number of the altered-part drawing. The altered-part drawing shall be identified by the words ALTERED-PART DRAWING immediately above the title block.

4.30 MODIFICATION DRAWING

A modification drawing depicts modifications to existing facilities/systems/equipment. A modification drawing may be used in the preparation of the modification kit or become a part of the instructions included in the modification kit. A modification drawing serves as a record of alterations made to equipment in the field and represents the as-built configuration.

4.30.1 APPLICATION. A modification drawing shall be used to describe a modification to be made to a completed item, usually after acceptance and delivery, but never without approval. The original records of the equipment as shipped shall include records of the equipment modified.

4.30.2 REQUIREMENTS. A modification drawing shall contain or reference all information necessary to accomplish the modification. For example, a modification drawing shall:

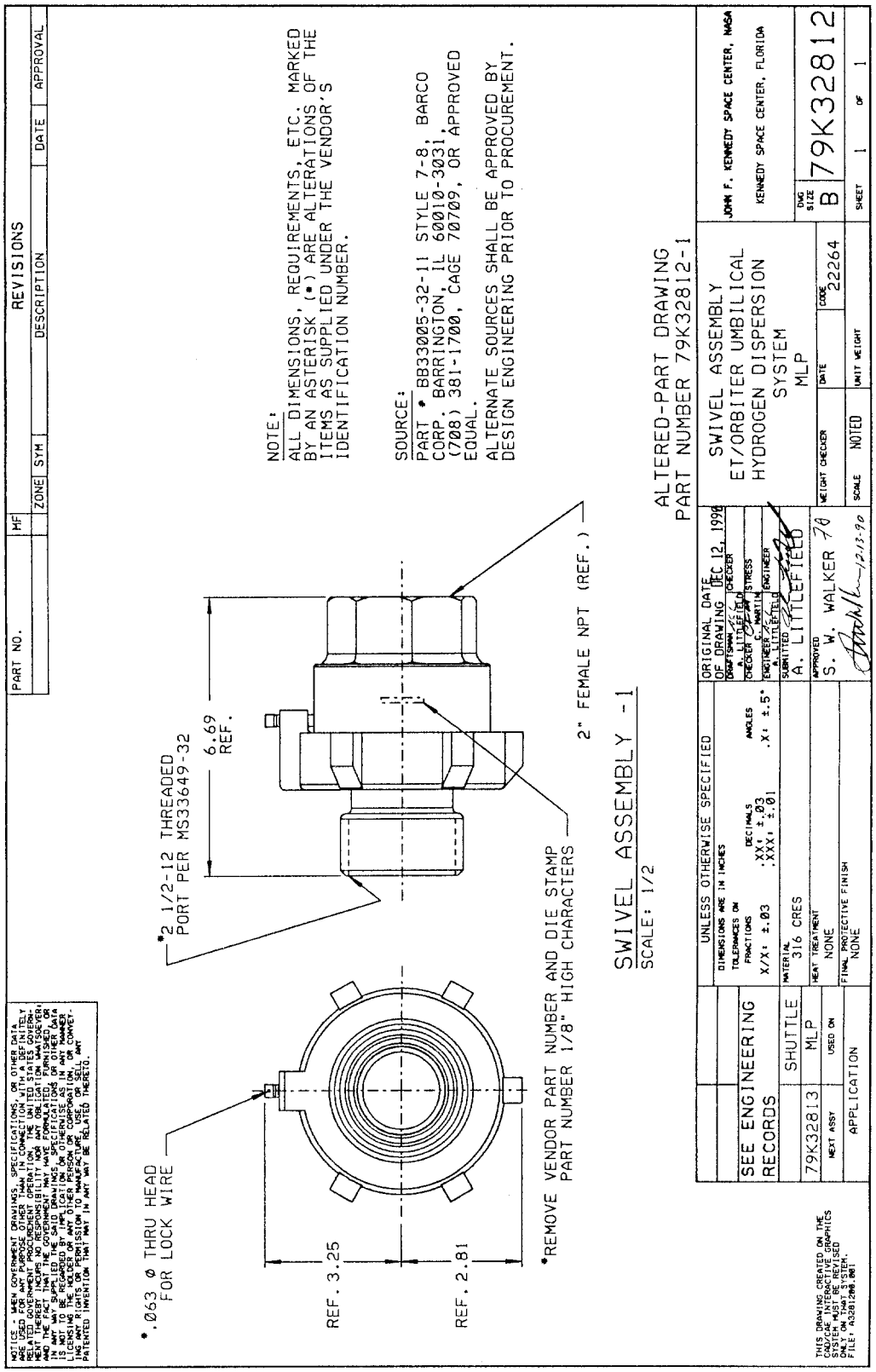


Figure 4-19. Typical Altered-Part Drawing

a. Identify the item to be modified and indicate its new identity, when required, after modification.

b. Show the item in sufficient detail to describe how the modification is to be accomplished, including before- and after-modification delineation or description.

c. List and identify all items to be removed and all items to be altered or added.

For all drawings directly affected by the modification drawing (e.g., installation drawings), a note on the affected drawing shall be added to state THIS DRAWING HAS BEEN CHANGED BY MODIFICATION DRAWING 79K12345. (If the affected drawing is not a maintained drawing, an engineering order to the drawing with the reference note shall be prepared and released.)

4.31 LAYOUT AND PROPOSAL DRAWINGS

A layout drawing presents the investigation and study of design, and a proposal drawing conveys its features to the customer. The drawings are identified and prepared by the same requirement as production drawings.

4.31.1 APPLICATION. Layout and proposal drawings shall be prepared for approval prior to the preparation and release of working drawings for the purpose of producing a contract item.

4.31.2 REQUIREMENTS. All layout and proposal drawings shall be identified by a number assigned by the documentation center in the same manner as production drawings with one exception: To identify the drawing as a layout or proposal drawing, the number used on the drawing may be the number assigned by the documentation center suffixed with the letter L for a layout drawing and the letter P for a proposal drawing. Layout and proposal drawings shall be further identified by the word LAYOUT or the word PROPOSAL, as applicable, placed in the drawing title block preceding the drawing title and a note DO NOT USE FOR FABRICATION.

4.32 UNDIMENSIONED DRAWING

An undimensioned drawing is a drawing that provides information for fabricating and inspecting parts. (See figure 4-14.)

4.32.1 APPLICATION. An undimensioned drawing shall be used for overlays and photographic processes in fabrication techniques.

4.32.2 REQUIREMENTS. An undimensioned drawing shall be prepared on dimensionally stable base film. Items such as printed-wiring masters, decal masters, and pattern detail shall be depicted by accurate scale layouts rather than by conventional dimensional methods.

4.33 BLOCK DIAGRAM

A block diagram consists of a line drawing with block outlines to designate units of functional groups.

4.33.1 APPLICATION. A block diagram shall be used to present information such as general arrangement studies, functional explanations, and product familiarization within a system, set, or item. (See figure 4-20.)

4.33.2 REQUIREMENTS. A block diagram shall be presented in as simple a form as possible. Blocks shall represent units or functions. Lines connecting blocks shall show relationships, direction of flow, sequence of operation, etc. Arrowheads shall be used on lines to indicate direction, generally from left to right, top to bottom. All necessary identifications and explanatory notes shall be entered. Identifying nomenclature shall be included within the block. Dashed-line blocks may be used to indicate optional items or testing functions.

4.34 SKETCH DRAWING

A sketch drawing is an informal drawing by an engineer or designer.

4.34.1 APPLICATION. A sketch drawing shall be used by engineers and designers for nonproduction work or to facilitate development, testing, or prototype work where there is no probability of a need for fixed records. Sketches shall not be used to revise released drawings, and engineering orders (EO's) cannot be issued against sketches.

4.34.2 REQUIREMENTS. A sketch drawing shall be of a standard format size. All sketch drawings shall be identified by a number assigned by the documentation center and approved by the responsible design engineer.

4.35 INTERFACE CONTROL DRAWING

An interface control drawing depicts physical and functional interface engineering requirements of an item that affects the design or operation of cofunctioning items. These drawings are used as design control documents, delineating interface engineering data coordinated for the purpose of: (1) establishing and maintaining compatibility between cofunctioning items, (2) controlling interface designs, thereby preventing changes to each item's requirements that would affect compatibility with cofunctioning subsystems, and (3) communicating design decisions and changes to participating activities. (See figure 4-21.)

4.35.1 APPLICATION. An interface control drawing shall be used to define design requirements between flight hardware and ground support equipment or facility systems or equipment.

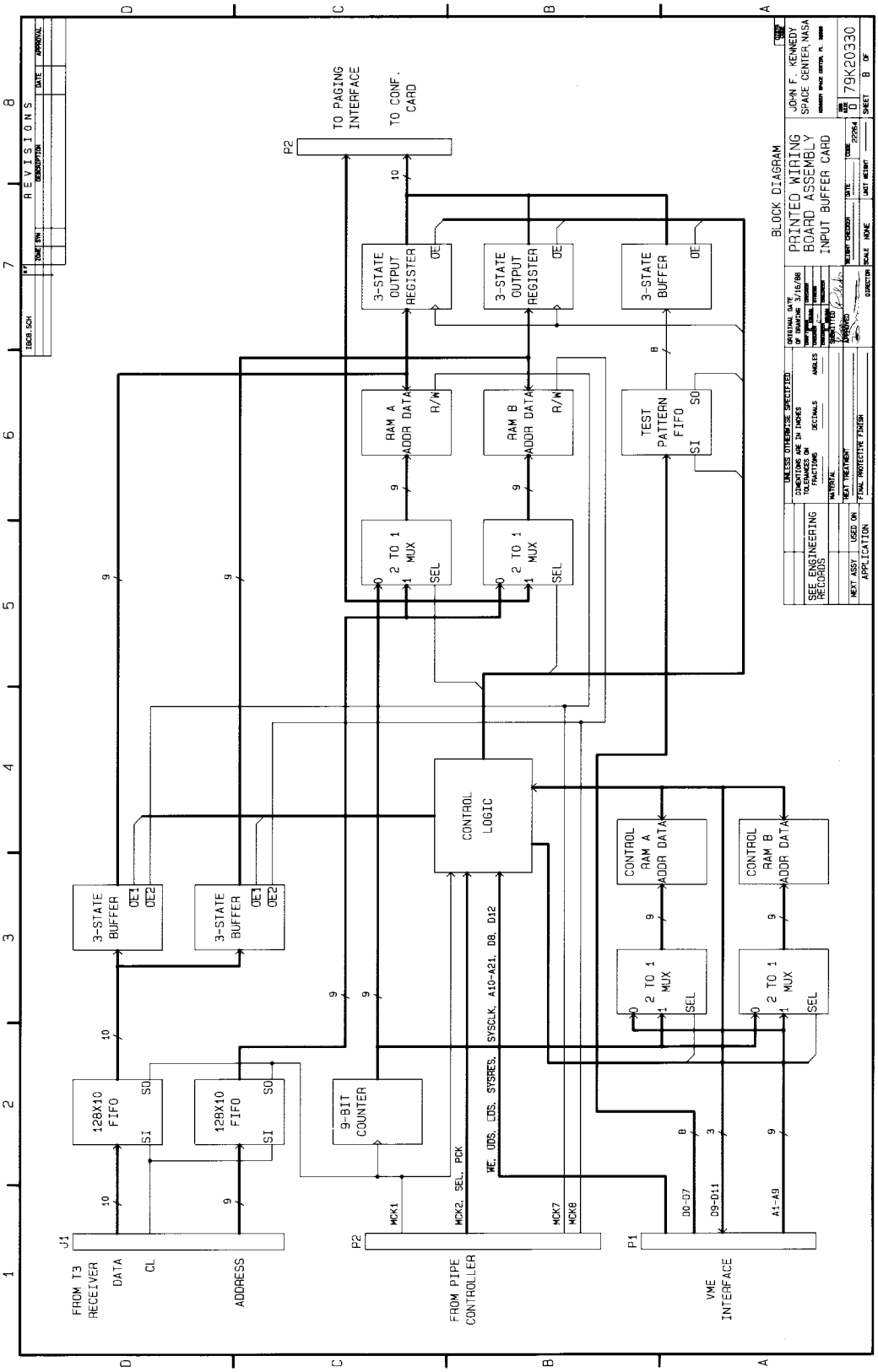


Figure 4-20. Typical Block Diagram

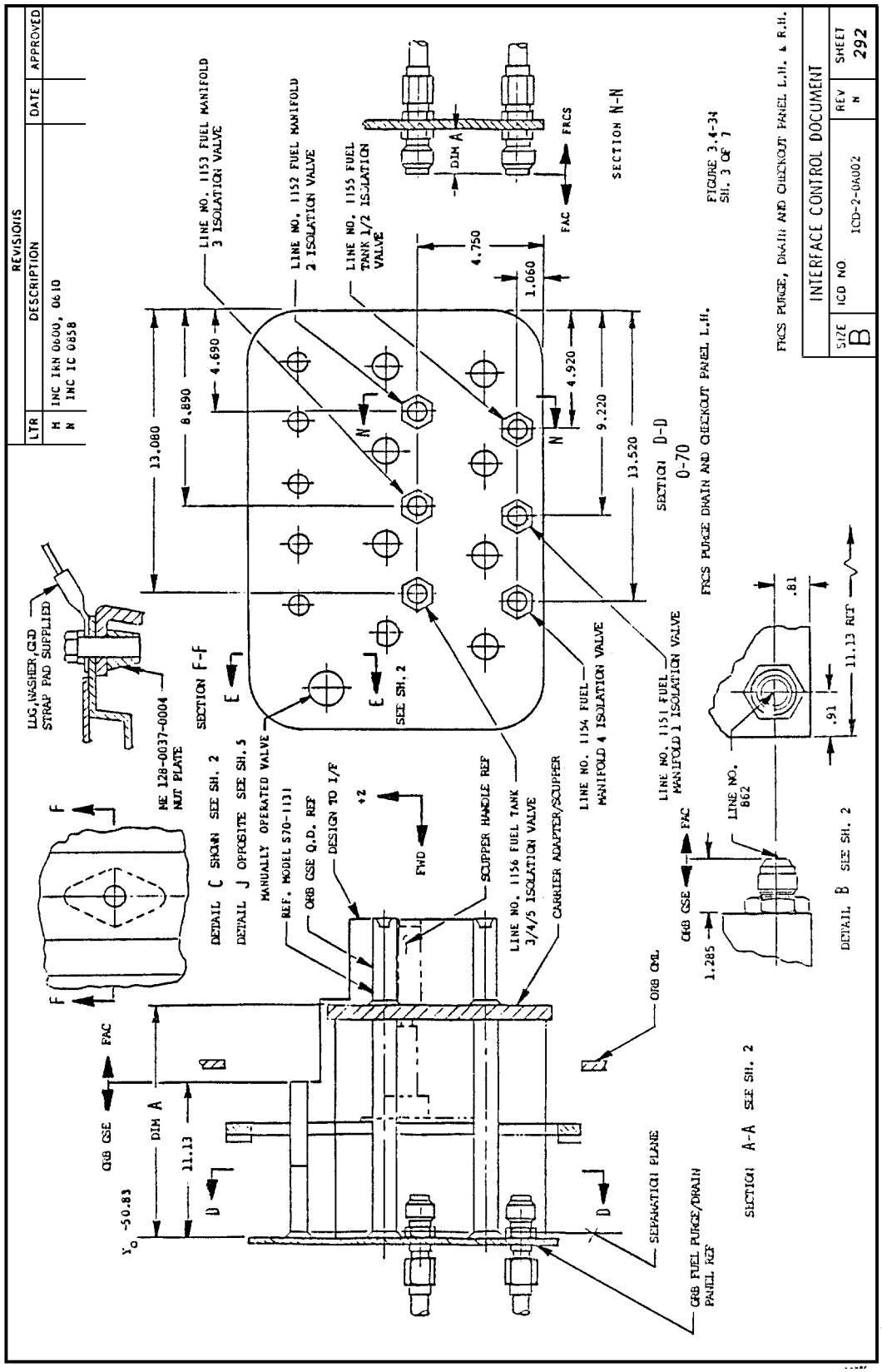


Figure 4-21. Interface Control Document

4.35.2 REQUIREMENTS. An interface control drawing shall delineate: (1) configuration and interface dimensional data applicable to the envelope, mounting, and mating of the items, (2) complete interface engineering requirements (e.g., mechanical, electrical, electronic, hydraulic, pneumatic, optical, etc.) that affect the physical or functional characteristics of cofunctioning items, and (3) any other characteristics that cannot be changed without affecting system design criteria. Interface control drawings may be categorized by facility, as necessary. The notation INTERFACE CONTROL DRAWING shall be shown adjacent to the title block.

4.35.3 CHANGES. An interface control drawing shall be changed through the preparation, approval, and release of an Interface Revision Notice (IRN). (See figure 4-22.) IRN's shall be prepared on JSC Form 69 and continued on JSC Form 69A. IRN's shall be incorporated into the interface control document by revision.

4.36 SYSTEM/EQUIPMENT PARTS LIST

A system/equipment parts list is a tabulation of line-replaceable units (LRU's) or other components that make up a system.

4.36.1 APPLICATION. A system/equipment parts list shall be applicable to all ground support equipment systems that do not contain an integral list of materials or a parts list on the system drawings.

4.36.2 REQUIREMENTS. A system/equipment parts list (figure 4-23) shall be organized numerically by mechanical find number (A-number) for mechanical systems and by reference designator for electrical systems. The list shall include the find number/reference designator, the drawing number, drawing sheet and zone, nomenclature, KSC part number, component procurement specification number, source maintenance and repair (SMR) code, and work unit code as applicable. The list shall be in find number/reference designator order.

4.37 ELECTRICAL WIRE RUNNING LIST

An electrical wire running list is a tabular drawing specifying wiring data that is pertinent to manufacturing and supplements the information contained on an electrical advanced schematic. (See figure 4-24.)

4.37.1 APPLICATION. An electrical wire running list shall be applicable to all electrical advanced schematics. If wiring information is provided clearly on the schematics, an electrical wire running list is not required.

4.37.2 REQUIREMENTS. A wire running list shall be identified by its own drawing number and shall be referenced on its associated assembly drawing.

INTERFACE REVISION NOTICE

AFFECTED ICD			IRN			
NO. ICD-2-0A002	REV M		2. TRACKING IDENTIFIER	3. NO.	4. SHEET 1 OF 2	
7. PROGRAM CODE SHUTTLE	8. LEVEL II		A.	0662	5. PANEL AFFECTED IWG	
9. TITLE SPACE SHUTTLE LAUNCH PAD AND PLATFORM			B. IC0874		6. INITIATED BY ROCKWELL INTERNATIONAL	
			C. PCIN 50762			
			10. THIS IRN EFFECTIVITY			
			SHUTTLE VEHICLE	STS-31, 32, 33, 35 & Subs		
			ORBITER	OV-102 & Subs		
11. REASON FOR CHANGE Add shield wiring requirements to the SSME's Emergency Cutoff Connector			EXTERNAL TANK	Ref. ET-32 thru 35, 37 & Subs		
			SOLID ROCKET BOOSTER	Ref. BI-025, -033 & Subs		
			MAIN ENGINE			
			LAUNCH AND LANDING			
			FLIGHT AND GROUND EQUIP. CONFIG.			
			FLIGHT AND GROUND OPS. SUPPORT STA.			
			SOLID ROCKET MOTOR			
			COFR NO.	N/A		

CHANGE ICD EFFECTIVITY	12. TO	13. FROM

14. IRN NO.	15. NEW IRN EFFECTIVITY	16. PREVIOUS IRN EFFECTIVITY

DESCRIPTION OF CHANGE

EDITORIAL NOTE:

This PIRN is a result of the PAD Avionics review.

Affects Table 5.4.6-3, which is for FRF's only.

This change will be first shown on STS-33, but the next FRF will not be until STS-~~53~~ 52, OV-105. | A2

1-17-90

A2-Amended 11-6-89/JAM/CWD
Amended 9-20-89 CWD

18. PREPARED BY	19. TECH. CONCURRENCE	20. ORGANIZATION	21. DATE
C. Du Lac, X2945	R. Hoole	D/286, TEST INTEGRATION	09/05/89

22.	SIGNATURE AND ORGN.	REV	DATE	SIGNATURE AND ORGN.	REV	DATE	SIGNATURE AND ORGN.	REV	DATE
∝	/S/ H. Makowski, LSO		9/22/89	(Lennie J. Kelly)		9/13/89	/S/ J. Fults		9/16/89
	/S/ J. G. Hangartner		9/22/89	/S/ Larry L. Mecca		9/26/89	/S/ W. R. Gore		10/16/89
	/S/ W. D. Goldsby JH.		9/22/89	/S/ Ralph Gonzalez		10/17/89	/S/ C. R. Biggerstaff		10/16/89
				G. A. Wolfelt 89		10/18/89	/S/ M. Kaul A. Hamid		10/16/89

23.	KSC APPROVAL	DATE	JSC APPROVAL	DATE	MSFC APPROVAL	DATE
CCBD NO.						
PRCBD NO.	S50762H	11/17/89				

JSC Form 69 (Oct 73) NASA-JSC

Figure 4-22. Interface Revision Notice (Sheet 1 of 2)

IRN NO. 0662	SHEET 2 OF2
ICD NO. ICD-2-0A002	REV M

IC0874

ITEM 1. To Table 5.4.6-3, Sheets 1 and 5 of 5 (ICD Sheets 861 and 865), change as follows:

(A) On Sheet 1, add the following notes:

(X) * The AWG wire for shielding, on both sides of the interface, is a jumper-wire from the pin to the braided shield of the cable.

(Y) * STS-26 thru ~~31~~ 30 & 34 cwo 9-20-89

(Z) * STS-31, 32, 33, 35 & Subs; OV-102 & Subs; ALL FRFs cwo 9-20-89

(B) On Sheet 5, to pin PP change as follows:

(a) In the DESCRIPTION column, add (Y) *.

(b) Duplicate the existing line and change as follows:

1. To the ORB & GND WIRE GAGE AWG columns, add 22.

2. To the GND LCT column, add GND.

3. To the DESCRIPTION column, add (X) * and (Z) *.

ISC Form 69A (Oct 73)

Figure 4-22. Interface Revision Notice (Sheet 2 of 2)

LRU PARTS LIST: LOA FUEL CELL SERVICING SYSTEM LH2/GH2 (B/L 10) DWG. NO.: 79K12093 REV.: A PAGE ___ OF ___
D4036 5/10/83

FIND NO/ REF DES	79K06003 SHEET/ ZONE	ITEM NOMENCLATURE	SIZE	PART NUMBER	MFG. CODE	SMR	WORK UNIT CODE
A88967	1-B16	FILTER, PNEUMATIC, 10 MICRON ABS	1/2"	79K80146-9		PAOFF	51FFHQBAAB
A88968	1-B16	VALVE, METERING, GLOBE	1/2"	79K80137-3 79K80059-2 (R)		PAOZZ	51FFHQBAAC
A88969	1-B16	VALVE, PNEUMATIC, 2W/2P, N.O.	3/8"	281483-0001 REV. F	99657	PAOZZ	51FFHQBAAD
A88970	1-B16	VALVE, SHUTOFF, ANGLE	1/4"	79K80049-1		PAOCZ	51FFHQBAAE
A88971	1-B16	FITTING, ORIFICE UNION	1/4" 0.010" DIA	79K80239-7		PAOZZ	51FFHQBAAF
A88973	1-C16	GAGE, PRESSURE, 0-10,000 PSI	4-1/2" DIAL	79K80170-12		PAOBZ	51FFHQBAAH
A88974	1-C16	TRANSDUCER, PRESSURE, 0-7500 PSI		79K03438S1N22		PAOLA	51FFHQBAAJ
A88975	1-B16	VALVE, SHUTOFF, GLOBE	1/2"	79K80059-2		PAOZZ	51FFHQBAAK
A88976	1-C15	VALVE, CHECK	1/2"	79K80186-3		PAOZZ	51FFHQBAAL
A88977	1-C15	VALVE, PNEUMATIC, 3W/2P, N.C.	1/2"	5A37 REV. B	21930	PAOFF	51FFHQBAAM
A88978	1-B15	REGULATOR, PRESS, SPRING-LOADED		79K80003-6		PAOFF	51FFHQBAAN
A88979	1-B15	VALVE, SHUTOFF, ANGLE	1/4"	79K80049-1		PAOCZ	51FFHQBAAP
A88980	1-B15	FITTING, ORIFICE, UNION	1/4" 0.010" DIA	79K80239-7		PAOZZ	51FFHQBAAQ
A88982	1-C15	GAGE, PRESSURE, 0-6000 PSI	4-1/2" DIAL	79K80170-11		PAOZZ	51FFHQBAAS
A88983	1-C15	TRANSDUCER, PRESSURE, 0-5000 PSI		79K03438S1N21		PAOLA	51FFHQBAAT

Figure 4-23. System/Equipment Parts List

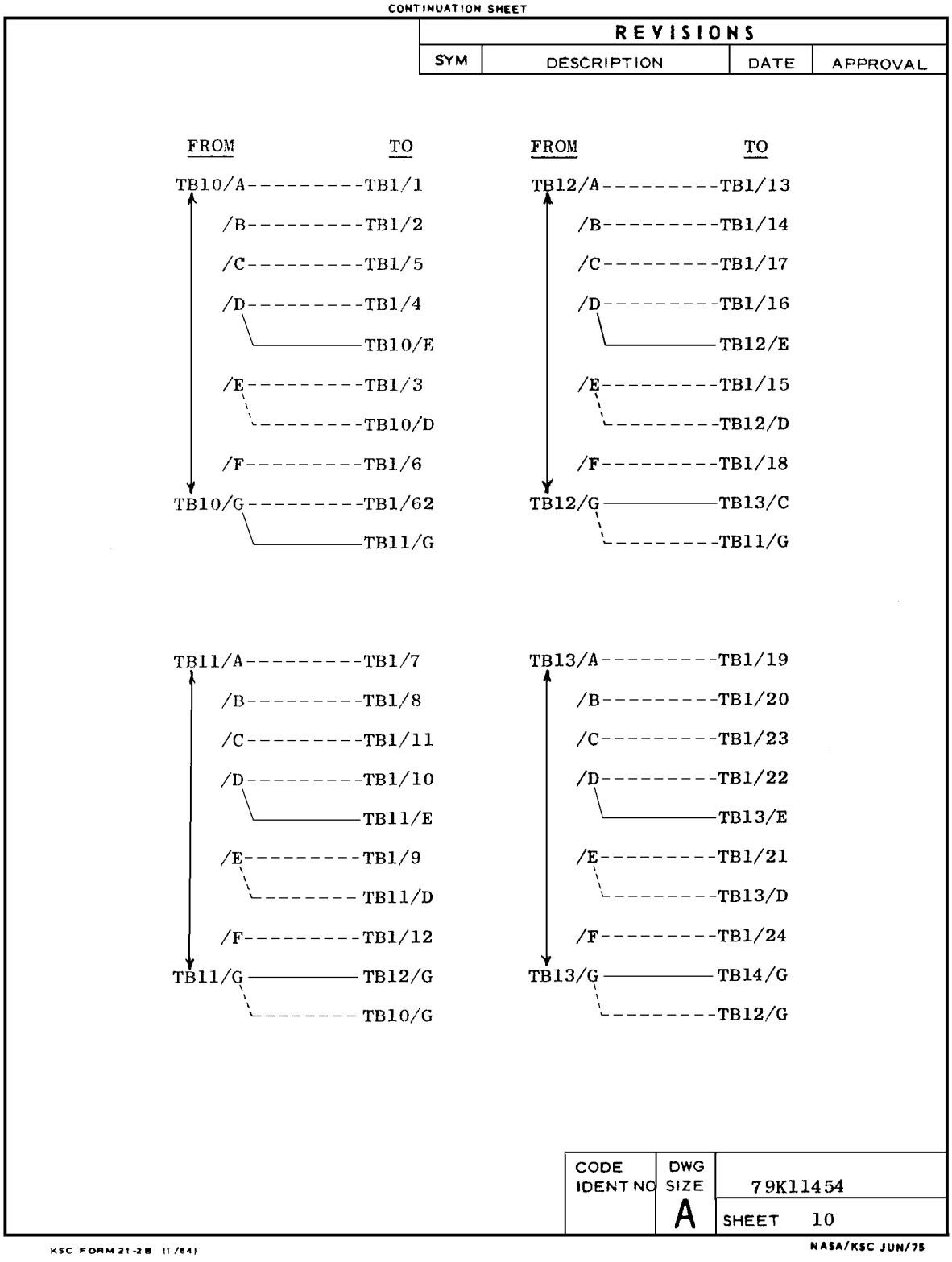


Figure 4-24. Typical Wire Running List

4.38 PATCH LIST

A patch list is a computer-generated listing of the required wiring for ground support equipment system patch boards. The list consists of all forward and reverse patches and magnetic tape used to check out a patch board wired to its applicable patch list.

4.38.1 APPLICATION. Patch lists shall be prepared for each system patch distributor. This listing (see figure 4-25) and an applicable magnetic tape shall be used to fabricate the system patch board in accordance with KSC-W-167. Engineering orders (see figure 4-26) shall be used to maintain patch board configuration as system requirements checks.

4.38.2 REQUIREMENTS. A patch list shall be a complete listing of all pins on a particular system patch board. The list shall contain all forward patches, reverse patches, and spare pins. EO's shall contain all delta configuration changes and show additions, deletions, and new spares. All forward and reverse changes shall be shown. The patch list shall be prepared and maintained utilizing the Wire List Maintenance (WILMA) system. Patch list preparation and maintenance utilizing WILMA shall be in accordance with the process shown in figure 4-27 and the following requirements:

a. New WILMA Patch List and EO Preparation.

(1) WILMA Input. Patch list and EO change input may be prepared on WILMA load forms (KSC Forms 21-169 and 21-169A) and forwarded with appropriate instructions for entry into WILMA.

(2) Validation Run. The input shall be entered into the WILMA program operation for a validation run. This run will not load the master data disk with the new patch list but will create an error listing that will be returned to the originator.

(3) Corrections. New WILMA load forms may be created to correct the errors listed for applicable patches to be submitted for another validation run on WILMA. The input validation run [a.(2)] and the procedure to correct the input [a.(3)] will be repeated as many times as required to get an error-free validation run.

(4) Load Run. The error-free input shall be submitted to WILMA for a load run. This run will load the patch list onto the master file, create a magnetic tape, and provide a copy of the patch listing or EO change listing.

(5) Release of Document. A copy of the patch list or EO shall be turned over to the originator for release.

NOTICE - When government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or cooporation, or conveying any rights or permission to manufacture, use, or sell patented invention that may in any way be related thereto.

APPLICATION		PART NO.	M F	REVISIONS			
NEXT ASSY	USED ON			SYM	DESCRIPTION	DATE	APPROVAL

PART IDENTITY SUFFIX NUMBER 1	DOCUMENT REVISION STATUS 2				
	REVISION LETTER	SHEETS AFFECTED	EO INC	DATE	APPROVAL

1 SUFFIX NUMBER SHALL BE ADDED TO THE BASIC PART IDENTITY FOR CONFIGURATION CONTROL PURPOSES. SEE LATEST EO OR REVISION TO THIS DRAWING AS APPLICABLE TO DETERMINE PROPER SUFFIX NUMBER.

2 THIS DRAWING WILL ONLY BE UPDATED PERIODICALLY. DOCUMENT REVISION LETTER ASSIGNMENT MADE AND CONTROLLED BY EO. SEE LATEST EO FOR CURRENT STATUS.

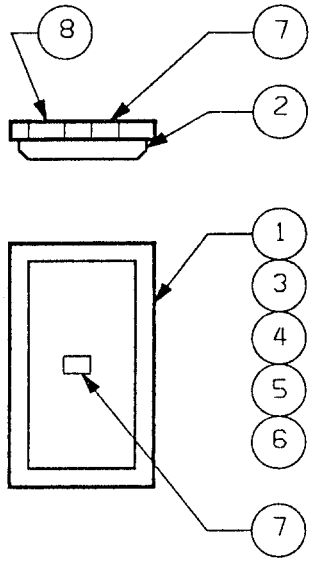
UNLESS OTHERWISE SECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES MATERIAL HEAT TREATMENT FINAL PROTECTIVE FINISH	ORIGINAL DATE OF DRAWING April 11, 1990 DRAFTSMAN / CHECKER TRACER / CHECKER ENGINEER / ENGINEER SUBMITTED APPROVED 4-11-90	PATCHBOARD ASSEMBLY AND WIRING LIST OPF-3 ECLSS, SSME, ECS 60 CONN REFDES 8046 SCALE NONE UNIT WT	JOHN F. KENNEDY SPACE CENTER, NASA KENNEDY SPACE CENTER FLORIDA DWG SIZE A 80K52716 SHEET 1 OF 96

KSC FORM 21-2 (REV. 9/65)

Figure 4-25. Typical Patch List (Sheet 1 of 4)

CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL



PATCHBOARD ASSY

80K52716 1

GENERAL NOTES:

1. PATCHING SHALL BE ACCOMPLISHED IN ORDER OF JACK NUMBER, LOWEST JACK TO THE HIGHEST, IN ACCORDANCE WITH KSC-W-167-A.

2. MARK 80K52716 AND APPLICABLE DASH NUMBER, AND OTHER DATA AS APPROPRIATE ON IDENTIFICATION PLATE, ITEM 8 PER KSC-STD-E-0015, ITEM 7 REF DES ONLY.

3. LEGEND:

PATCHING DATA

J12/0----J12/V WIRE TO BE PATCHED
J12/V....J12/0 WIRE PREVIOUSLY PATCHED
J12/X----J13/N
J12/X----J13/S
J12/X----J14/X
J12/X----J15/B
J12/X----J21/F
— WIRES TO BE PATCHED, CRIMPED IN COMMON END CAP

TESTING DATA

0 = CONTINUITY TEST
00 = HI-POT TEST
000 = CONTINUITY TEST PLUS HI-POT TEST PLUS DWELL TIME

CODE IDENT NO	DWG SIZE	80K52716
	A	SHEET 2 OF 96

KSC FORM 21-20 (REV. 3/76)

Figure 4-25. Typical Patch List (Sheet 2 of 4)

CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL

ASSY DASH NO. & NO. REQD.	FIND NO. OR ITEM NO.	MFG CODE	PART OR STOCK NO. DRAWING NO.	DESCRIPTION
1	9		80K52716	MAG TAPE
1	8		75M50393-8	IDENT. PLATE
2	7		75M50393-7	IDENT. PLATE
A/R	6		M16878/ 178GE9	WIRE,AWG #20,19 STRAND MIN WHITE, MIL-W-16878
A/R	5		MS25274-4	END CAP
A/R	4		MS25274-3	END CAP
A/R	4		C4777-G	PATCH PIN
1	3	14301	40M19484	PATCHBOARD COVER
1	1	14301	IPB-3840-M-S	PATCHBOARD
1	-	-	80K52716 1	PATCHBOARD ASSEMBLY

LIST OF MATERIAL

CODE IDENT NO	DWG SIZE	80K52716
	A	SHEET 3 OF 96

KSC FORM 21-20 (REV. 3/76)

Figure 4-25. Typical Patch List (Sheet 3 of 4)

PATCHBOARD ASSEMBLY AND WIRING LIST

DATE - 04-11-1990 PAGE - 04

DRAWING NUMBER - 80K52716 REVISION - EO -

REFERENCE DESIGNATOR - 8046 DISTRIBUTOR SIZE - 60

PATCH RACK LOCATION - OPF-3 ECLSS/ECS/SSME

FROM PLUG/PIN		TO PLUG/PIN	AWA CODE	LAST EO #	*	FROM PLUG/PIN		TO PLUG/PIN	AWA CODE	LAST EO #
01/A	-----	20/A	000		*	01/H	-----	12/I+	000	
01/A	-----	20/F	0		*	01/J	-----	12/J+	000	
01/A	-----	20/L	0		*	01/K	-----	12/K+	000	
01/A	-----	20/S	0		*	01/L	-----	12/M+	000	
01/B	-----	20/X	000		*	01/M	-----	12/N+	000	
01/B	-----	20/C+	0		*	01/N	-----	29/G	000	
01/B	-----	20/H+	0		*	01/P	-----	29/J	000	
01/B	-----	20/N+	0		*	01/R	-----	29/L	000	
01/C	-----	29/C	000		*	01/S	-----	29/N	000	
01/D	-----	19/AA	000		*	01/T	-----	29/R	000	
01/D	-----	19/FF	0		*	01/U	-----	29/T	000	
01/D	-----	29/M+	0		*	01/V	-----	29/V	000	
01/D	-----	29/P+	0		*	01/W	-----	29/F+	000	
01/E	-----	19/U	000		*	01/W	-----	29/H+	0	
01/E	-----	19/Z	0		*	01/X	-----	29/X	000	
01/E	-----	29/R+	0		*	01/X	-----	29/Z	0	
01/E	-----	29/T+	0		*	01/Y	-----	29/B+	000	
01/F	-----	05/Y+	000		*	01/Y	-----	29/D+	0	
01/F	-----	29/A	0		*	01/Z	-----	01/A+	000	
01/G	-----	12/H+	000		*	01/Z	-----	02/MM	0	

Figure 4-25. Typical Patch List (Sheet 4 of 4)

GROUND SUPPORT EQUIPMENT
ENGINEERING ORDER

1. ENGINEERING ORDER NUMBER
EO 19-79K30107

2. SHEET 1 OF 4 SHEETS

3. EFFECTIVITY (PAD AND VEHICLE)

4. DISPOSITION OF OLD PARTS
(X) REWORK

5. TITLE OF DRAWING
PATCHBOARD ASSEMBLY AND WIRE LIST
MLP-3
REFERENCE DESIGNATOR - 6601 54 CONNECTOR

6. REASON FOR CHANGE
ADDITIONAL PATCHING REQUIRED - 17-INCH DISCONNECT PURGE.

REFERENCE - P-S063000V-G

7. DESCRIPTION OF CHANGE

UPDATE DOCUMENT REVISION LETTER FROM - U
TO --- V

CHANGE PART IDENTIFICATION SUFFIX NUMBER FROM - 18
TO --- 19

UPDATE AWA DATA REVISION LETTER FROM - U
TO --- V

UPDATE WIRE LIST AND AWA PER THIS EO.

* * * * * * * *

FIND NO*MFR CODE*DWG SIZE*PART NO*DWG REV*ACTION*QUAN*UNIT WT*REMARKS

8. SIGNATURES

REQUESTER	DATE	DRAFTSMAN	DATE
[signature]	9/19/90	** WILMA **	09-19-1990
STRESS	DATE	SYSTEM ENGINEER	DATE
		[signature]	9/20/90
CHECKER	DATE	APPROVED BY	DATE
B. Facey	9/20/90	[signature]	9/20/90

KSC FORM 21-34 (REV. 8/64)

Figure 4-26. Patch List Engineering Order (Sheet 1 of 2)

E N G I N E E R I N G O R D E R

PAGE - 2

W I R E L I S T C H A N G E S

WIRE LIST - 79K30107 REVISION - V EO NUMBER - 19

WIRING CHANGES DELETE	WIRING CHANGES ADD	AWA CHANGES DELETE	AWA CHANGES ADD	
J01/K -- J34/M		J01/K -- J34/M		
	J01/U -- J48/A		J01/U -- J48/A	0
	J01/W -- J34/H		J01/W -- J34/H	0
	J01/C+ -- J48/J		J01/C+ -- J48/J	0
	J01/E+ -- J34/S		J01/E+ -- J34/S	0
	J01/K+ -- J48/T		J01/K+ -- J48/T	0
	J01/N+ -- J34/A+		J01/N+ -- J34/A+	0
	J01/S+ -- J39/KK		J01/S+ -- J39/KK	0
	J02/F+ -- J34/B		J02/F+ -- J34/B	0
	J02/H+ -- J34/K		J02/H+ -- J34/K	0
	J02/J+ -- J34/U		J02/J+ -- J34/U	0
	J02/T+ -- J48/W		J02/T+ -- J48/W	0
	J02/X+ -- J48/D		J02/X+ -- J48/D	0
	J02/Z+ -- J48/M		J02/Z+ -- J48/M	0
	J09/V -- J39/A	J09/V	J09/V -- J39/A	000
	J09/V -- J48/E		J09/V -- J48/E	0
	J09/W -- J34/F	J09/W	J09/W -- J34/F	000
	J09/X -- J39/C	J09/X	J09/X -- J39/C	000
	J09/X -- J48/N		J09/X -- J48/N	0
	J09/Y -- J34/P	J09/Y	J09/Y -- J34/P	000
	J09/Z -- J39/E	J09/Z	J09/Z -- J39/E	000
	J09/Z -- J48/X		J09/Z -- J48/X	0
	J09/A+ -- J34/Y	J09/A+	J09/A+ -- J34/Y	000
		J34/B	J34/B -- J02/F+	0
	J34/D -- J48/B	J34/D	J34/D -- J48/B	000

Figure 4-26. Patch List Engineering Order (Sheet 2 of 2)

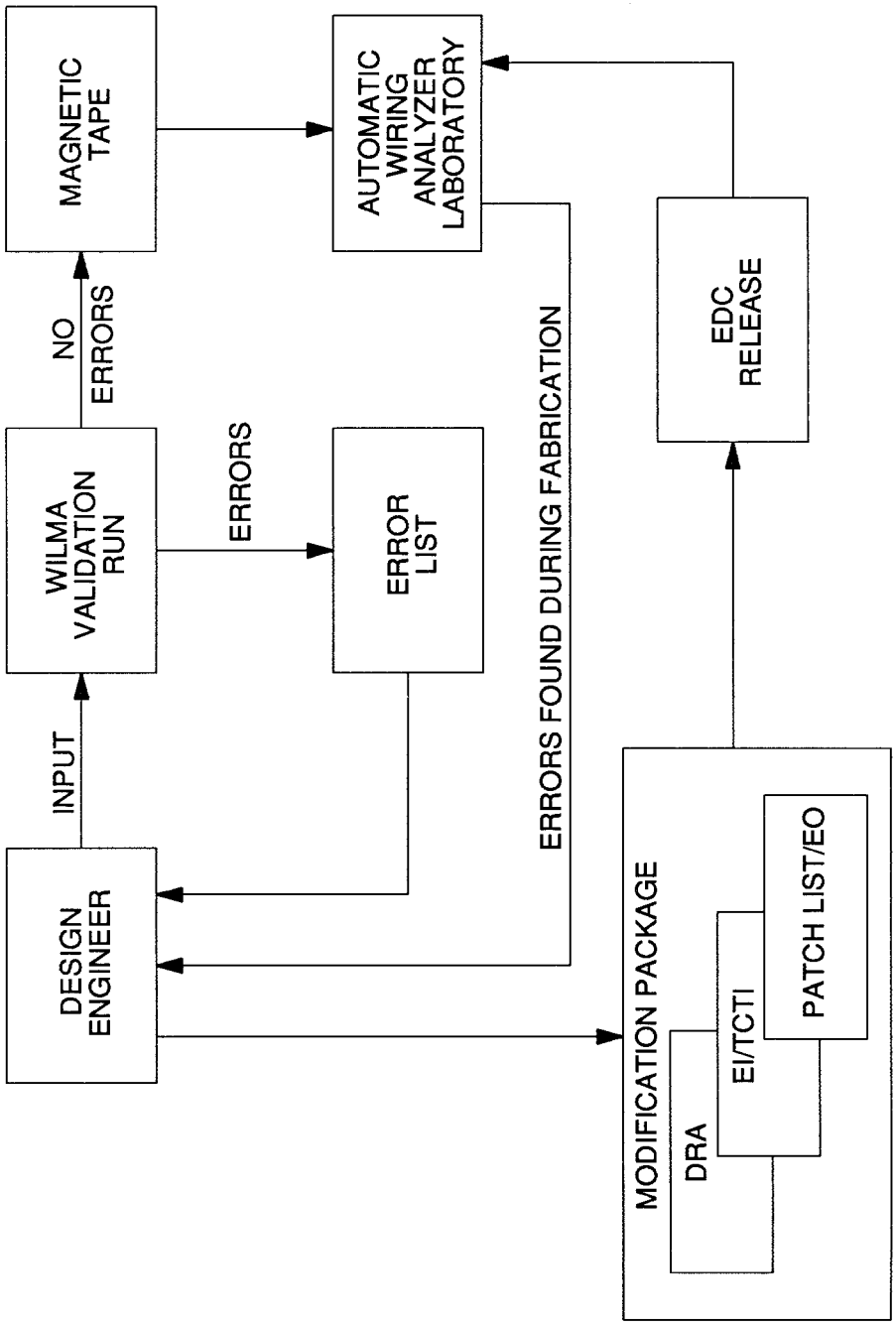


Figure 4-27. Processing Patch Lists and EO's

(a) Magnetic Tape. The magnetic tape shall be delivered to the Automatic Wiring Analyzer (AWA) Laboratory to copy the data onto a floppy disk for future use as required.

(b) Modification Package. A modification package shall be prepared in order to implement the wiring of the patch board. Errors found during wiring of the patchboard or the AWA checkout shall be forwarded to the originating design engineer for correction.

b. Preparation of WILMA Load Forms.

(1) WILMA Load Forms/New List. The WILMA load form (KSC Forms 21-169 and 21-169A) may be used to provide input data to create new patch lists for system patchboards. When more than 20 patches are required, the load form continuation sheet shall be used. The sheets shall be numbered in consecutive page order. The originator shall sign the load form in the spaces provided.

(a) Forward Patching. Only forward patching shall be placed on these load forms. Reverse patching will be automatically generated on the WILMA output listing.

(b) Spares. Spares shall not be indicated; the WILMA output listing will automatically handle spare pins.

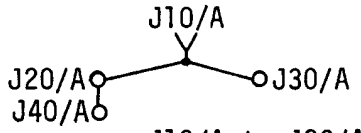
(c) General Format. When two plugs/pins are required to be patched together, the lowest numbered plug/pin shall always appear in the "From" column. When more than two plugs/pins are required to be patched together (i.e., electrically common), the lowest numbered plug/pin shall be considered the common point and WILMA load forms will be as follows:

J10/A to J20A
J10/A to J30A
J10/A to J40A
(etc., where J10/A is the lowest common point)

See figure 4-28 for further clarification and examples.

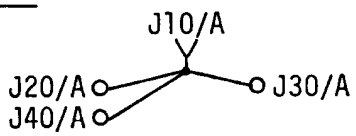
(2) WILMA Load Forms/Revision List (EO's). The Wire List Maintenance Load Form (KSC Forms 21-168 and 21-168A) may be used to provide input data to revise existing patch lists. For numeric data elements, it shall be justified right and the remaining blocks of the field shall be filled with zeros. For alphanumeric (or alpha) data elements, it shall be justified left and the remaining blocks of the field shall be left blank. When more than 20 patch changes are required, a continuation

Incorrect:



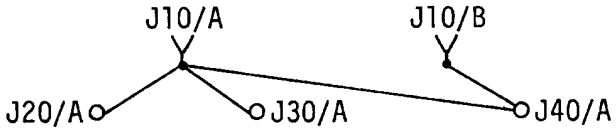
J10/A to J20/A
J10/A to J30/A
J20/A to J40/A

Correct:



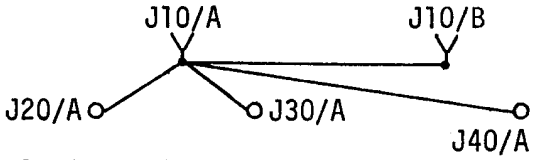
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A

Incorrect:



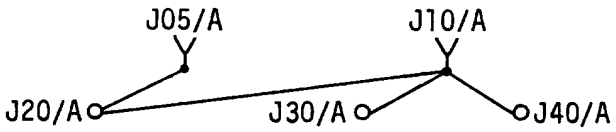
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A
J10/B to J40/A

Correct:



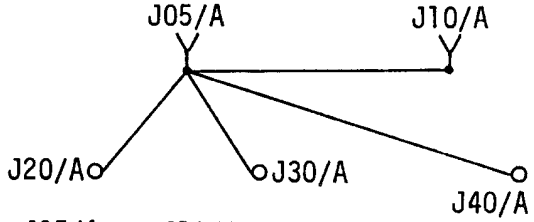
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A
J10/A to J10/B

Incorrect:



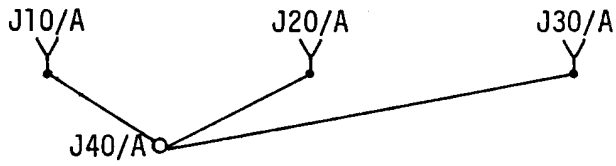
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A
J05/A to J20/A

Correct:



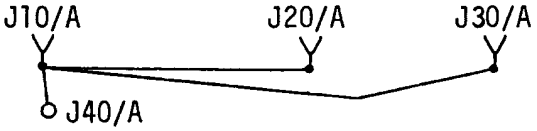
J05/A to J10/A
J05/A to J20/A
J05/A to J30/A
J05/A to J40/A

Incorrect:



J10/A to J40/A
J20/A to J40/A
J30/A to J40/A

Correct:



J10/A to J20/A
J10/A to J30/A
J10/A to J40/A

Figure 4-28. Example of Correct/Incorrect Patching

sheet shall be used. The sheets shall be numbered in consecutive page order. The responsible originator shall sign the load form in the spaces provided.

(a) Forward Patching. Only forward patching shall be placed on these load forms. Reverse patching will be automatically generated on WILMA output listing.

(b) Spares. Spares shall not be indicated; the WILMA output EO list will automatically handle spare pins.

(c) General Format Examples. The following are aids to be used when patch changes (EO's) are issued to existing patch lists in the WILMA data base.

1 To change an existing patch to the lowest numbered plug/pin, the existing patch shall be deleted and the new patch added as follows:

Existing Patches
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A

Delete: J10/A to J20/A
Add: J05/A to J20/A

Existing Patches After Change
J05/A to J20/A
J10/A to J30/A
J10/A to J40/A

2 To change the lowest numbered plug/pin, all patches to the lowest plug/pin shall first be deleted then any new patches to the new low plug/pin shall be added as follows:

Existing Patches
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A

where the new low plug/pin J05/A is to replace J10/A, therefore:

Delete: J10/A to J20/A
J10/A to J30/A
J10/A to J40/A

Add: J05/A to J20/A
J05/A to J30/A
J05/A to J40/A

3 Not patching to the lowest plug/pin in an EO will result in a "duplicate plugs" error from WILMA and the EO will not be processed as follows:

Existing Patches
J10/A to J20/A
J10/A to J30/A
J10/A to J40/A
Incorrect: Add: J05/A to J30/A
J20/A to J20/B
Correct: Delete: J10/A to J30/A
Add: J05/A to J30/A
J10/A to J20/B

Existing Patches After Change
J10/A to J20/A
J05/A to J30/A
J10/A to J40/A
J10/A to J20/B

4.38.3 SPECIAL CONSIDERATIONS. The WILMA listing program requires special handling and specific input requirements to function smoothly and efficiently. The following is provided so the user can understand WILMA's limitations as well as its capabilities.

a. Input.

(1) Forms. All inputs should be on the applicable KSC load forms.

(2) Data. Only forward patch data shall be loaded. Reverse patch data will be rejected as error data in the validation program. Only the lowest-to-highest pin patches will be recognized as legal.

(3) EO Sequence. When revisions are required, a corresponding EO number and revision letter are automatically recorded to keep the WILMA master file data and the released EO data in parallel (e.g., EO 1 and revision A, EO 2 and revision B, and EO 3 and revision C, etc.). WILMA incorporates every EO into the master tape wire list when it is loaded.

b. Output.

(1) Listings. When a new patch list is loaded into the WILMA file, a copy of the listing is generated for release. A listing needed at a later date shall be the latest revision in the WILMA file. The originator can request this listing. No previous listings are available to the originator from WILMA. If a past listing is needed, a copy of the original listing and all EO's must be obtained from EDC.

(2) EO Listing. A copy of an EO listing is generated at the time the WILMA master file is loaded. No extra EO listing may be generated at a later date from WILMA. Extra copies of EO's must be requested from EDC after release.

(3) Magnetic Tape. A magnetic tape is generated when a new wire list is loaded. It shows all forward patches, reverse patches, and spare pins. When an EO is loaded, a magnetic tape of revisions is created.

4.39 SYSTEM/EQUIPMENT DOCUMENTATION LIST

A system/equipment documentation list is an indentured listing of all the technical documentation related to KSC systems, facilities, and equipment as defined by the operation and maintenance documentation (OMD) baseline document, 79K09579.

4.39.1 APPLICATION. The system/equipment documentation list shall be applicable to all KSC facilities, systems, and equipment.

4.39.2 REQUIREMENTS. A system/equipment documentation list shall be prepared utilizing KSC Form 21-343. (See figure 4-29.) Indenturing for this list corresponds to the next lower assemblies. An A-size format cover sheet shall be used for approval purposes.

4.40 INDEX LIST

An index list is a tabulation of lists applicable to an end item or to the complete system to which the list applies. An index list is maintained documentation.

4.40.1 APPLICATION. An index list shall be applicable to all ground support equipment.

4.40.2 REQUIREMENTS. An index list shall tabulate all data lists applicable to an end item or all index lists of the subordinate end items for a complete system. An index list is not required if there is only one data list for the complete end item or if the top data list includes all applicable data lists.

SYSTEM/EQUIPMENT DOCUMENTATION LIST

INDENTURE 1	2	3	4	5	6	7	SIZE	DOCUMENT NUMBER	TITLE	GROUND SYSTEM CONFIGURATION	MAINTAINED YES	MAINTAINED NO
			X				A	76125-640 (FSCM A0235)	FINAL DESIGN CALCULATIONS, MLP-1, BLAST DECK STAIR ENCLOSURE - 79K15215	MLP-1, -2, -3		X
			X				A	76125-645 (FSCM A0235)	STRUCTURAL DESIGN CALCULATIONS, MLP-1, MODIFICATIONS TO BLAST DECK	MLP-1, -2, -3		X
		X					F	79K07667	MLP-1 MECHANICAL AND ELECTRICAL INSTALLATION	MLP-1	X	
		X					F	79K06383	MLP-1 ELECTRICAL CONTROL SYSTEM INSTALLATION	MLP-1	X	
			X				A	79K07808	MLP-1 MECHANICAL AND ELECTRICAL INSTALLATION, TECHNICAL SPECIFICATIONS FOR	MLP-1	X	
			X				A	ME-SDI (FSCM A0521)	MLP-1, INDEX TO SHOP DRAWINGS FOR DRAWING 79K07667	MLP-1		X
		X					F	79K07050	MODS TO ML NO. 2 FOR SPACE SHUTTLE, MLP-2	MLP-2	X	
			X				A	79K07051	MODS TO ML NO. 2 FOR SPACE SHUTTLE, MLP-2, TECHNICAL SPECIFICATIONS FOR	MLP-2	X	
			X				A	2M-SDI (FSCM A0235)	MLP-2, INDEX TO SHOP DRAWINGS FOR DRAWING 79K07050	MLP-2		X
		X					F	79K11397	MLP-2 MECHANICAL AND ELECTRICAL INSTALLATION	MLP-2	X	

INDENTURE 1	2	3	4	5	6	7	SYSTEM/EQUIPMENT TITLE	SYSTEM/EQUIPMENT IDENTIFIER	APPROVED	DATE	SHEET		DWG. NO.	REV
							Mobile Launcher Platform	LUFSRM1000	LLS	5-3-85	4 OF	A	79K24560	B

KSC FORM 21-343 (4/78)

Figure 4-29. System/Equipment Documentation List

4.41 ELECTRICAL POWER RISER DIAGRAM

Electrical ac power riser diagrams represent multiconductor power circuits as a single line. The various devices in the circuit (such as transformers, motor starters, switches) and the connected loads are shown in simplified schematic form. This diagram locates power equipment and loads within a structure. Each ac power panel shall have a panel schedule, which is to be a part of the drawing.

4.41.1 APPLICATION. Electrical power riser diagrams are applicable to service voltage ac power distribution systems in all buildings and structures.

4.41.2 REQUIREMENTS. The following requirements shall be applicable for the preparation of an electrical power riser diagram.

a. The orientation of an electrical power riser diagram shall be in elevation, rather than plan, to show interconnecting vertical runs.

b. Distribution power panelboards and control centers shall be shown in three-line diagram form to show all conductors, buses, circuit breakers, fuses, contactors, relays, etc., individually. Wire numbers and terminators shall be identified. All spare breakers and unused spaces shall be shown.

c. All circuits, protective devices, switch devices, panelboards, controllers, etc., shall be identified by reference designators.

d. Each breaker and fuse shall be identified and noted with its rating and capacity, such as breaker frame size and type.

e. Each panel, controller, or assembly shall be identified and noted with its rating, description, and location.

f. The operational and maintenance interfaces between the system and other support and services systems shall be shown.

g. Each power panel shall have a panel schedule, which is to be a part of the drawing (e.g., general-purpose lighting panels).

4.42 ELECTRICAL PANEL SCHEDULE

An electrical panel schedule is a tabulated drawing of the internal configuration of an alternating current power panel.

4.42.1 APPLICATION. Electrical panel schedules shall be applicable to all 60-hertz facility power systems.

4.42.2 REQUIREMENTS. A panel schedule shall be a part of the single-line power riser diagram. The panel schedule shall contain the panel location and its identification, the type of panel, associated circuit breakers, panel capacity and feeder source, breaker trip settings with the loads being supplied, spare breakers, and empty spares.

4.43 SYSTEM MECHANICAL SCHEMATIC/ELECTROMECHANICAL CONTROL DIAGRAM (SMS/EMCD)

Generally, ground support equipment or a system will have either a system mechanical schematic (SMS) or an electromechanical control diagram (EMCD). When both an SMS and an EMCD are required, these drawings shall be combined into a single SMS/EMCD drawing.

An SMS is a purely mechanical drawing with no electrical references shown. An SMS shows all mechanical and electromechanical components (both active and passive) that make up the piping system involved. Offline components (e.g., solenoid valves, controllers, etc.) are shown within the outline of the cabinet or container and are restricted to an area or location.

An EMCD shows mechanical and electromechanical components with electrical interfaces defined. Many passive components (e.g., flex lines, hoses, nonflow hand valves, test and calibration parts, etc.) may be omitted. All components are shown relative to flow or position as related to functional use. Offline components are not restricted to the cabinet or container outline and area or location.

An SMS/EMCD is an SMS with the electrical interfaces defined. An SMS/EMCD specifies the point-to-point connections of mechanical components and the electrical interface. Measurement numbers are indicated for all Launch Processing System (LPS) functions.

4.43.1 DEFINITIONS.

a. Dedicated Element or Assembly. A dedicated element or assembly is the lowest element or assembly to be defined on system mechanical schematics and electromechanical control diagrams. These items are essential to the function, flow, and operation of the system and are identified by part number, find number, and/or reference designator numbers in accordance with this manual.

b. Electromechanical Control Diagram (EMCD). An electromechanical control diagram specifies the point-to-point connections of mechanical components. Passive mechanical components may be omitted to improve clarity of the drawing. The electrical interface with mechanical components shall be specified. Measurement numbers shall be indicated for all LPS functions.

c. System Mechanical Schematic (SMS). A system mechanical schematic specifies the point-to-point connections of mechanical components. The SMS shall contain both active and passive mechanical components.

d. Interface Element or Assembly. An interface element or assembly is an element not dedicated to the system but one that interfaces with the system.

4.43.2 APPLICATION. A system mechanical schematic and an electromechanical control diagram shall be used primarily in system operations, maintenance, troubleshooting, training, procedure development, software development, and configuration management. (See figure 4-30.)

4.43.3 REQUIREMENTS.

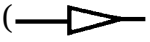
a. System Mechanical Schematic. A system mechanical schematic shall be used for and in preparation of operation and maintenance documentation (OMD) and for preliminary design reviews and critical design reviews. The following requirements shall be applicable in the preparation of system mechanical schematics:

(1) The systems shall be laid out from left to right as much as possible (e.g., the storage area on the left and the vehicle on the right).

(2) The fluid flow shall be horizontal as much as possible (e.g., the supply to the right and the return to the left).

(3) Dedicated mechanical elements shall be shown solid.

(4) Interfacing elements shall be dashed boxes. If possible, interfacing system block diagrams shall be referenced and program and KSC level (Level II and III) interface control documents shall be referenced at the interface line.

(5) Secondary fluid flow direction shall be indicated by arrows, unfilled for gas (), and filled for liquid ().

(6) Main fluid flows may be heavy lines with interior arrows spaced periodically along the pipe, unfilled for gas () and filled for liquid ().

(7) The program model number, element title, and find numbers shall be identified as applicable.

(8) Location of mechanical elements shall be defined (e.g., OPF, MLP, etc.).

(9) The tide block shall indicate the operation area and system depicted.

(10) General notes shall be placed in the upper right side.

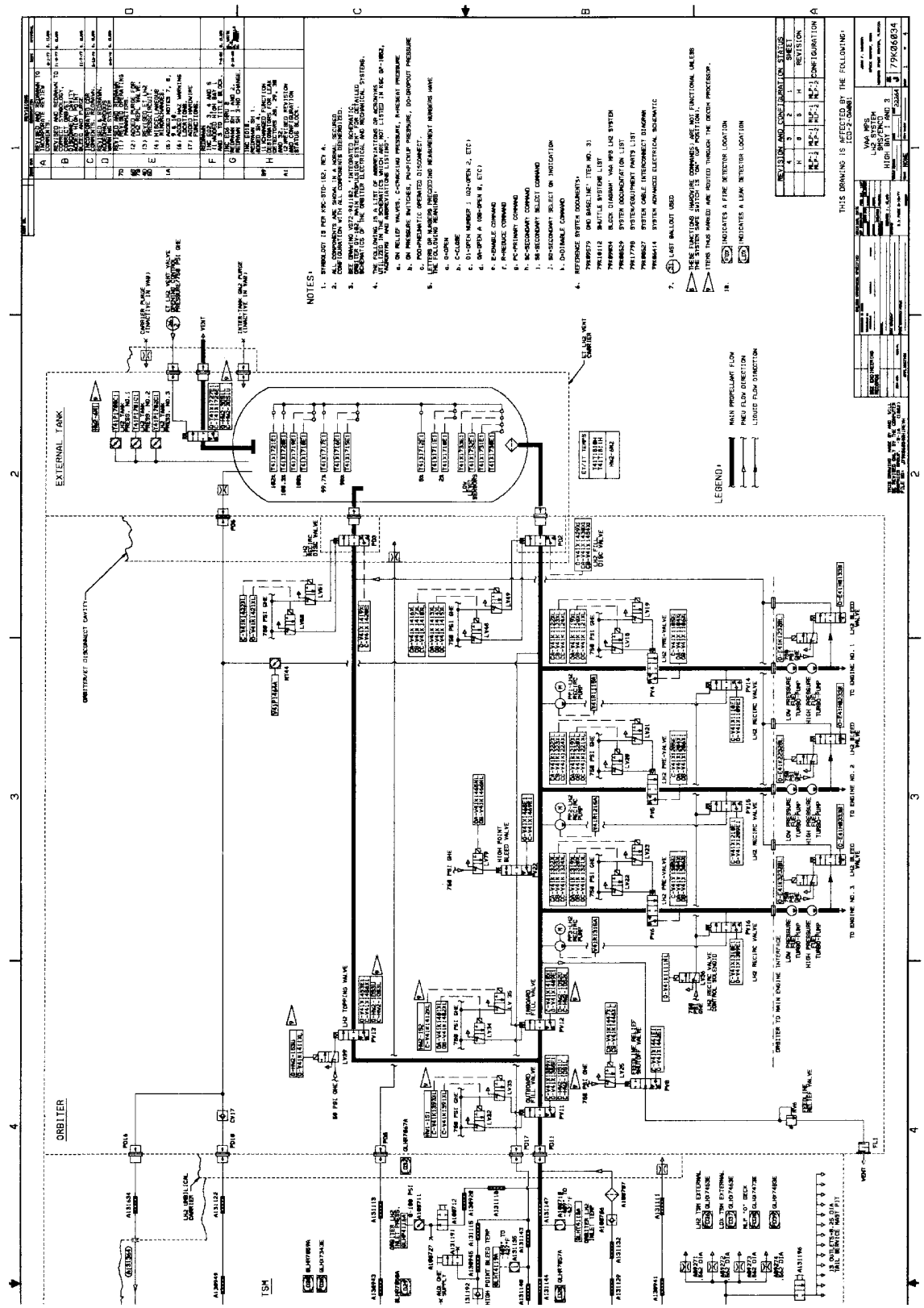


Figure 4-30. Typical System Mechanical Schematic/Electromechanical Control Diagram

(11) All mechanical components (active or passive) shall be shown.

(12) The drawing shall be structured to place system components in the same relative location as the actual equipment to the maximum degree possible.

(13) Where possible, all system components shall be shown on the primary sheet and arranged by panels or elements (end items). Where space prohibits, the main flow elements shall be on the primary sheet and the supporting elements shall be placed on a secondary sheet and "balled out" to the primary sheet.

(14) At interfaces with other systems, the first active component shall be shown, and the interfacing document shall be referenced.

(15) Interfaces with flight element hardware shall reference the ICD line number. Applicable ICD drawing numbers shall be noted near the title block.

b. Electromechanical Control Diagram. When required for the development of software, an electromechanical control diagram shall be developed from the system mechanical schematic. The electromechanical control diagram shall have a different drawing number than the system mechanical schematic and shall be prepared in accordance with the system mechanical schematic requirements. The following requirements shall also apply.

(1) Passive components may be omitted to improve drawing clarity (e.g., filters, hand valves, etc.).

(2) All main flow components and associated operators shall be shown on the primary sheet.

(3) The active parts of the elements (end items) used to operate the basic system shall be shown.

(4) Secondary sheets shall be used to show the functional components supporting the main flow (e.g., gases, power, etc.). Two secondary sheets are generally required – one for electrical subsystems and one for mechanical subsystems.

(5) Measurement numbers shall be indicated for all LPS functions. Where space permits, numbers shall be defined in boxes adjacent to the component. Where space does not permit, the measurement box shall be remotely located and connected to the component via a dashed line. Where applicable, a table/matrix may be used. Table references shall be depicted close to the components.

(6) The electrical interface with mechanical components shall be shown.

c. System Mechanical Schematic/Electromechanical Control Diagram . When required for development of software, the SMS/EMCD shall be prepared in accordance with the requirements for a system mechanical schematic. The following requirements shall also apply:

(1) Measurement numbers shall be indicated for all LPS functions. Where space permits, numbers shall be defined in boxes adjacent to the component. Where space does not permit, the measurement box shall be remotely located and connected to the component via a dashed line. Where applicable, a table/matrix may be used. Table references shall be depicted close to the components.

(2) The electrical interface with mechanical components shall be shown.

(3) All drawings may be on J-size format and shall be legible when reduced to B-size.

(4) Lettering templates and/or other mechanical devices shall be used for all drawing text. Lettering in the field of the drawing shall be uppercase Gothic and 5 mm (3/16 inch) high for headings (e.g., legends, general notes, abbreviations, etc.), uppercase and 4-mm- (5/32-inch-) high Gothic for general text. In all cases, lettering shall be large enough to permit reduction from J-size to B-size without loss of readability.

(5) Graphic symbols shall be in accordance with KSC-STD-152-2. Special symbols may be added to the legend as required. Solid lines shall always denote elements or assemblies that are part of the system defined by the OMD baseline document, 79K09579. Dashed lines shall always denote other elements or assemblies that are not part of the system defined by the SMS/EMCD. Phantom lines shall always denote segregation of areas or location (e.g., rooms, Mobile Launcher Platform/pad, Mobile Launcher Platform/Vehicle Assembly Building); this line shall not be used to separate elements or assemblies unless the elements or assemblies are in different areas or locations.

d. Drawing Maintenance. An SMS/EMCD shall depict the designed configuration. An EO against the SMS/EMCD, SMS, or EMCD shall be generated and submitted with each design package if appropriate. Outstanding SMS, EMCD, and SMS/EMCD EO's shall be incorporated into the next revision in accordance with this manual.

4.44 STANDARD INTERFACE DOCUMENT (SID)

A standard interface document is an engineering drawing that defines ground support equipment and facility system interfaces available to flight vehicle and payload users within a facility. (See figure 4-31.)

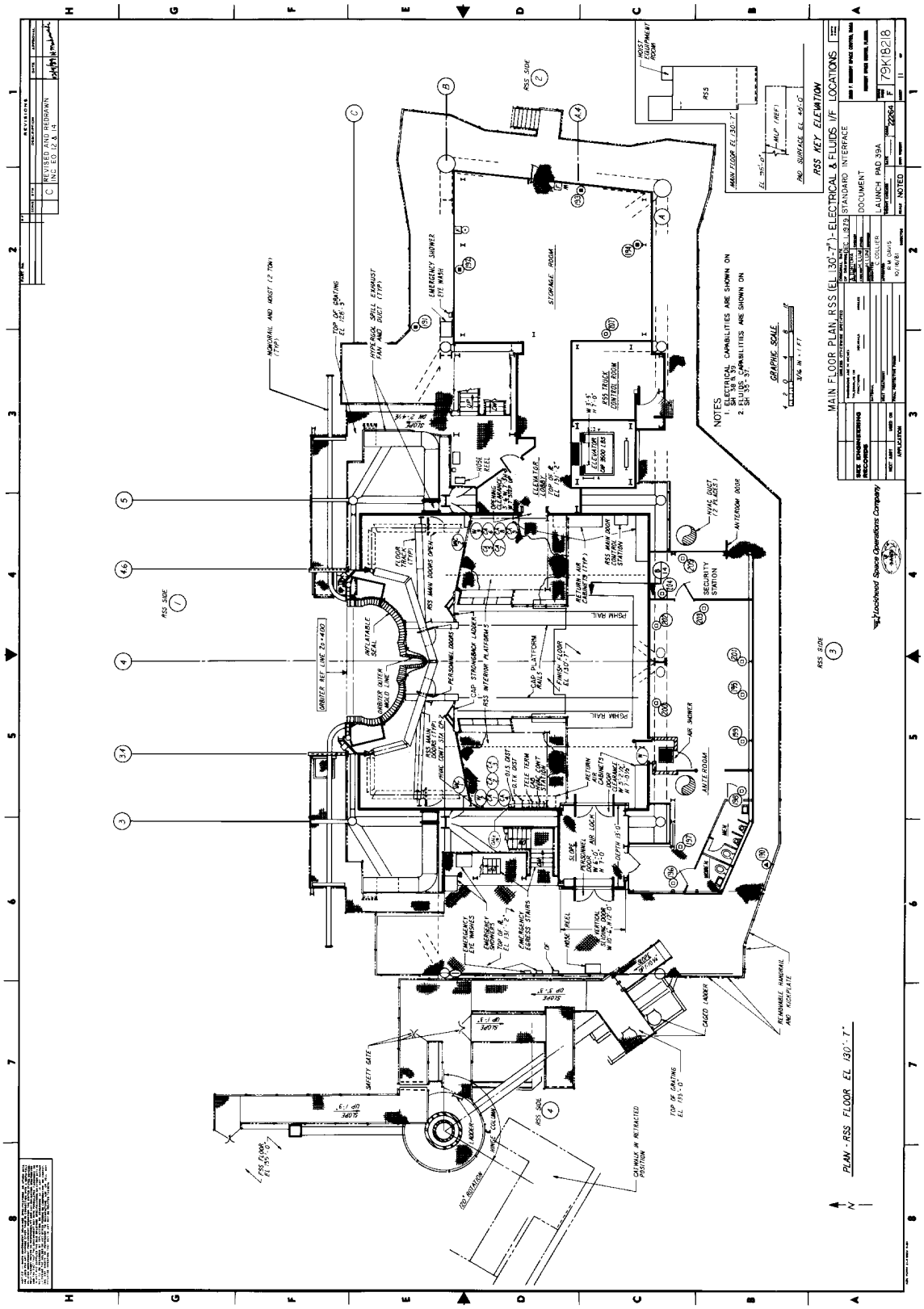


Figure 4-31. Typical Standard Interface Document

4.44.1 APPLICATION. A standard interface document shall be applicable to those facilities that process vehicle flight hardware and contain ground support equipment and facility systems that provide fluid servicing, electrical checkout, and handling capabilities to the flight and payload hardware.

4.44.2 REQUIREMENTS. The standard interface document shall be divided into the following sections:

a. General Layout and Information. The general layout and information section shall contain a title or cover sheet, an index sheet, abbreviations/acronyms, legend and general notes, a site plan, and a general orientation plan and elevations.

b. Area Layout. The area layout section shall contain plans and elevations of specific areas of the facility and locate ground support equipment and facility system interfaces. The following types of interfaces shall be shown: ac power receptacles, grounding plates, payload ground support equipment interface panel details, fluid panel locations and connection details, and hoist/crane capabilities.

c. System and Services. The system and services section shall contain detailed specifications, schematics, diagrams, and ground support equipment characteristics necessary to adequately describe the interfaces.

d. Interface Tables. The system and services section shall contain a tabular listing of all ground support equipment and facility system interfaces within the facility. Detailed characteristics shall be listed with each interface (e.g., interface symbol, interface identification, equipment function, media, pressure, flow rate, temperature, volts, phase, circuit breaker ratings, frequency, etc.)

4.45 HARDWARE INTERFACE MODULE (HIM) CONFIGURATION DOCUMENT (HCD)

An HCD is a computer listing that reflects the configuration of a particular Launch Processing System hardware interface module. (See figure 4-32.)

4.45.1 APPLICATION. An HCD shall be applicable to each system that is controlled or monitored through a Launch Processing System hardware interface module.

4.45.2 REQUIREMENTS. An HCD shall be generated and modified by the HIM Configuration Document System (HCDS), an inactive software set residing in the LPS Central Data System (CDS). The detailed requirements for preparation, format, and modification of an HCD shall be in accordance with DL-NED No. 009.

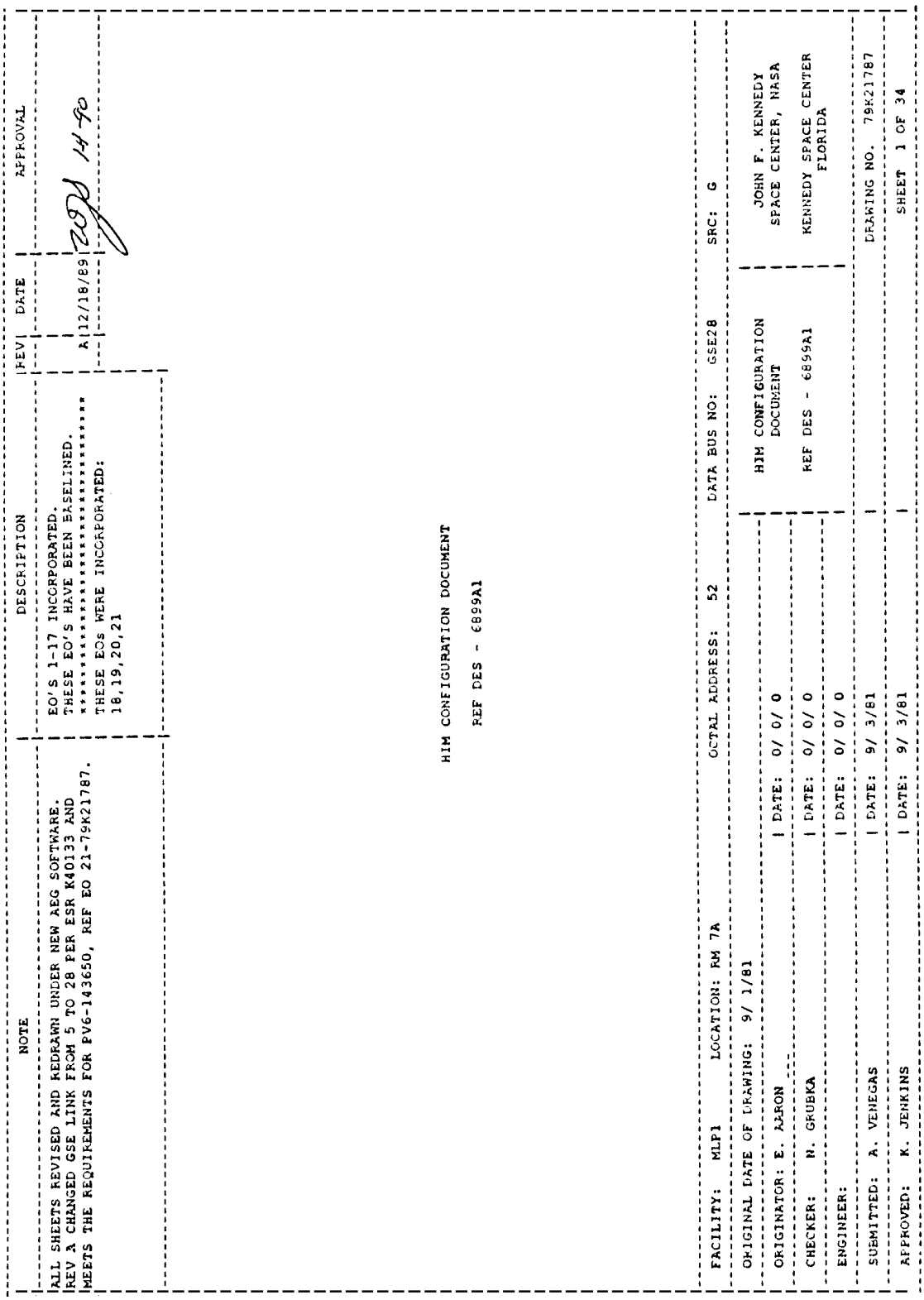


Figure 4-32. Typical HIM Configuration Document (Sheet 1 of 4)

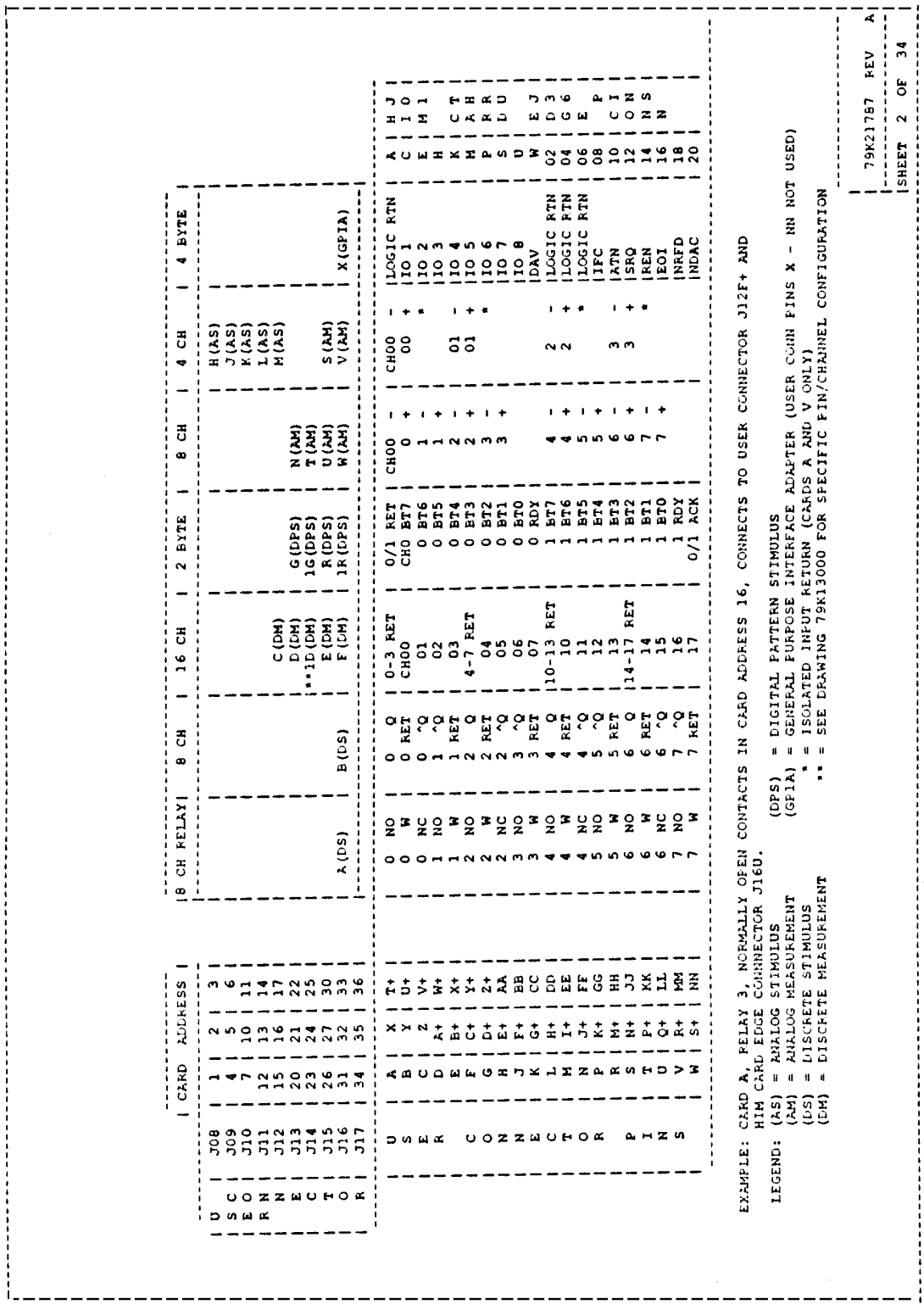


Figure 4-32. Typical HIM Configuration Document (Sheet 2 of 4)

CONTINUATION SHEET

HIM REF DES 6899A1 HIM OCT ADD 52 DATE INSTALLED LOCATION RM 7A

J05 BACKUP POWER

LOCATION REF DES OF SPLITTER/COMBINER

HIM GROUND SINGLE HIM GROUND DOUBLE DATA BUS NO GSE28

J07 CONNECTOR INTERFACE

J07/A - REMOTE CUTOFF <----------:
J07/C - REMOTE CUTOFF RETURN <-------:
J07/W+- REMOTE CUTOFF <----------:
J07/Y+- REMOTE CUTOFF RETURN <----:
J07/D -
J07/E -
J07/F -
J07/G - WIPER <----------:
J07/H - : FAIL
J07/J - N O CONTACTS <----: RELAY
J07/K - : OUTPUTS
J07/L - N C CONTACTS <----:
J07/M -
J07/N -
J07/P -
J07/R -
J07/S -
J07/T -
J07/U -
J07/V -
J07/W -

USER CARD CONFIGURATION

USER JACK	CARD OCT ADD	CARD TYPE	USER JACK	CARD OCT ADD	CARD TYPE
J08	1	ADS	J13	20	NAM
	2	ADS		21	NAM
	3	ADS		22	DDM
J09	4	ADS	J14	23	DDM
	5	DDM		24	ADS
	6	DDM		25	SAM
J10	7	DDM	J15	26	UAM
	10	NAM		27	DDM
	11	NAM		30	SAM
J11	12	ADS	J16	31	ADS
	13	DDM		32	DDM
	14			33	NAM
J12	15	ADS	J17	34	ADS
	16	DDM		35	DDM
	17	DDM		36	SAM

79K21787 REV A

SHEET 3 OF 34

Figure 4-32. Typical HIM Configuration Document (Sheet 3 of 4)

HIM CONFIGURATION DOCUMENT

PAGE 4 OF 34

HIM REF DES NO - 6899A1 | HIM OCTAL ADDRESS - 52 | CARD DESIGNATOR - MC | DWG NUMBER - 79K21787

HIM JACK - | LINK - GSE28 | CARD SYSTEM - MASTER CONTROL | REV - A

HIM CARD OCTAL ADDRESS - 0 | SPECIAL SETUP - | GTST - CMDS=N/A; MEAS=NO

PIN	USE	CH	FC	FUN. DES.	NOMENCLATURE	TYPE	STYP	LOGIC0	LOGIC1	RATE	SYSTEM	EQ#
		0	0	HIM052DM01	052 FAIL SIGNAL	DM	BD	OFF	ON	1	SW	0
		0	0	HIM052DPM3	052 STATUS REGISTER I	DPM	BIN			1	SW	0
		0	1	HIM052DPS1	052 CMD WORD DECODE ENABLE	DPS	OCT				SW	0
		0	2	HIM052DPS2	052 WRAPAROUND TEST	DPS	OCT				SW	0
		0	3	HIM052DPS3	052 AUX FUNCTION BUS ENABLE	DPS	OCT				SW	0
		0	5	HIM052DM09	052 EXECUTE SW STATUS	DM	BD	OFF	ON	1	SW	0
		0	5	HIM052DPM4	052 STATUS REGISTER II	DPM	BIN			1	SW	0
		0	6	HIM052DPM1	052 CDP CH. ADDRESS SW READ	DPM	BIN			1	SW	0
		0	7	HIM052DPM2	052 CDP CMD WORD SW READ	DPM	BIN			1	SW	0
		1	0	HIM052DM02	052 POWER SUPPLY FAILURE	DM	BD	OFF	ON	1	SW	0
		1	5	HIM052DM10	052 LINE POWER FAILURE	DM	BD	OFF	ON	1	SW	0
		2	0	HIM052DM03	052 ACK TIMEOUT	DM	BD	OFF	ON	1	SW	0
		2	5	HIM052DM11	052 RECEIVER ERROR	DM	BD	OFF	ON	1	SW	0
		3	0	HIM052DM04	052 MULTIPLE ACK	DM	BD	OFF	ON	1	SW	0
		3	5	HIM052DM12	052 SPARE	DM	BD	OFF	ON	1	SW	0
		4	0	HIM052DM05	052 RDY TIMEOUT	DM	BD	OFF	ON	1	SW	0
		4	5	HIM052DM13	052 CARD TYPE	DM	BD	OFF	ON	1	SW	0
		5	0	HIM052DM06	052 BUS TEST ERROR	DM	BD	OFF	ON	1	SW	0
		5	5	HIM052DM14	052 CARD MODE	DM	BD	OFF	ON	1	SW	0
		6	0	HIM052DM07	052 LOGIC ERROR	DM	BD	OFF	ON	1	SW	0
		6	5	HIM052DM15	052 OPERATING MODE-LSB	DM	BD	OFF	ON	1	SW	0
		7	0	HIM052DM08	052 OVER TEMP WARNING	DM	BD	OFF	ON	1	SW	0
		7	5	HIM052DM16	052 OPERATING MODE-MSB	DM	BD	OFF	ON	1	SW	0

NOTE: FUNCTION DESIGNATORS ARE SHOWN ON THE FIRST LINE OF THE PIN GROUP WITHOUT REGARD TO ACTUAL PIN ASSIGNMENT.

Figure 4-32. Typical HIM Configuration Document (Sheet 4 of 4)

4.46 OPERATION AND MAINTENANCE REQUIREMENTS AND SPECIFICATIONS DOCUMENT (OMRSD)

An OMRSD is a document that defines the operations and maintenance requirements that are imposed on systems and equipment by the design or development organization.

4.46.1 APPLICATION. An OMRSD shall be applicable to each GSE system where operation and maintenance requirements are necessary.

4.46.2 REQUIREMENTS. An OMRSD shall include the scope of the document and shall identify the OMD baseline number, program model number, and the system documentation list. The OMRSD shall contain the general requirements, notes (when used), a list of reference documents, and any definitions (if applicable). The individual OMRSD requirements shall be numbered and listed on KSC Form 21-374 (figure 4-33). KSC Form 1-7 shall be used as the OMRSD cover sheet and KSC Form 21-2D (figure 4-34) shall be used for other text.

OPERATION AND MAINTENANCE REQUIREMENTS AND SPECIFICATIONS

SYSTEM	WUC NUMBER	OMR&D DWG. NUMBER	REVISION
MOBILE LAUNCHER PLATFORM	LUFSRM1000	79K24565	B
SUBSYSTEM	WUC NUMBER	PMN	
		N/A	

REQUIREMENT			MEASUREMENT OR STIMULUS	SPECIFICATION	INTERVAL/CONSTRAINTS/REMARKS
WUC NO.	RCN	DESCRIPTION			
LUFSRM .004		PERIODICALLY INSPECT THE MLP STRUCTURE		INSPECT MLP-1, 2 AND 3 GIRDERS AND TRUSSES FOR INCIPIENT STRUCTURAL DISTRESS PER 79K29961 - MLP STRUCTURAL INSPECTION REQUIREMENTS.	A. AS SPECIFIED IN 79K29961 B. STS-26 AND SUBS C. PRIOR TO SRB STACKING ON THE MLP D. 79K29961

KSC FORM 21-374 (REV. 5/79)

SHEET 7 OF 7

Figure 4-33. Typical OMRSD Data on KSC Form 21-374

CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	REV. SHEET NO. REV. REV. LETTER ADDED PMN N/A	10-01-86	
B	REV. DWG. REV.	4-07-87	

OPERATION AND MAINTENANCE REQUIREMENTS AND SPECIFICATIONS DOCUMENT

MOBILE LAUNCHER PLATFORM (MLP)

1. SCOPE

This document establishes the Operations and Maintenance requirements for Mobile Launcher Platform No. 1, 2 and 3 defined in Drawing 79K24560 (System Documentation List) for OMD B/L (79K09579), Item No. 418.02, PMN N/A.

2. GENERAL REQUIREMENTS

Verify that the Mobile Launcher Platform configuration has been checked in accordance with Drawing 79K05493 and inspected prior to installation of the SRBs.

3. NOTES

Legend for "Interval/Constraints" column:

A: Interval
B: Effectivity
C: Notes, Constraints, Caution
D: Source, Reference

4. REFERENCE DOCUMENTS

DWG/DOC	REV.	TITLE
79K24560	C	System Documentation List
79K04211	E	Mods to Convert ML No. 3 to MLP No. 1 for Space Shuttle - Design Criteria
79K05493	A	MLP Space & Weight Allocation
79K05455	B	MLP-1 Drawing Tree
79K17750	A	MLP-2 Drawing Tree
79K30099	New	MLP-3 Drawing Tree

CODE IDENT NO	DWG SIZE	79K24565
	A	SHEET 2 OF

KSC FORM 21-2D (REV. 3/78)

Figure 4-34. Typical OMRSD Data on KSC Form 21-2D (Sheet 1 of 2)

CONTINUATION SHEET

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	REV. SHEET NO.	10-01-86	

5. OMD B/L (79K09579) ITEM NO. 418.02 WUC SYSTEM DEFINITION

WUC	PMN	TITLE
LUFSRM1000	NA	Mobile Launcher Platform No. 1
LUFSRM2000	NA	Mobile Launcher Platform No. 2
LUFSRM3000	NA	Mobile Launcher Platform No. 3

NOTE: This document does not establish configuration nor is there any relationship between the sequential paragraph numbers contained herein and test or checkout sequence.

6. DEFINITIONS

A. VALIDATION:

Verification that the equipment/system meets the operational needs of the Operations & Maintenance (O&M) user and is part of the turnover process from the design agency to the O&M agency. (One time only.)

B. COMPONENT:

A part or any combination of parts, subassemblies and assemblies mounted together as one unit and normally capable of independent operation in a variety of situations.

CODE IDENT NO	DWG SIZE	79K24565
	A	SHEET 3 OF

KSC FORM 21-2D (REV. 3/78)

Figure 4-34. Typical OMRSD Data on KSC Form 21-2D (Sheet 2 of 2)

SECTION V

DRAWING TITLES AND ITEM NOMENCLATURE

5.1 GENERAL

The titles of drawings and the nomenclature for parts and materials detailed on drawings shall be in accordance with the requirements herein. The drawing title and the item nomenclature shall be clearly identified in order to distinguish them from similar drawings, parts, or items. Item nomenclature should be brief and simple yet complete enough to adequately describe the hardware.

5.2 REQUIREMENTS

Drawing titles and item nomenclature shall be in all capital letters. A drawing title or item nomenclature shall consist of two parts as described by the following paragraphs. The overall drawing title shall be the same on all sheets of the drawing.

5.2.1 FIRST PART. The first part of the drawing title shall consist of a basic name and modifiers, as required.

5.2.1.1 Basic Name. The basic name shall be a noun or noun phrase. This identifying noun or noun phrase shall establish the basic concept of an item.

Examples:
CABINET
PUMP
PUMP ASSEMBLY
VALVE

5.2.1.2 Modifiers. A modifier shall be separated from the basic name by a comma and from any preceding modifier by a comma. A modifier may be a single word or a modifying phrase. The first modifier shall serve to narrow the area of concept established by the basic name; succeeding modifiers shall continue a narrowing of item concept by expressing a different type of characteristic. A word directly qualifying a modifying word shall precede the word it qualifies, thereby forming a modifying phrase; for example, ELECTRICAL EQUIPMENT. The word ELECTRICAL qualifies the word EQUIPMENT and precedes it in the modifying phrase.

Examples:
CABINET, ELECTRICAL EQUIPMENT
PUMP, LOX TRANSFER
PANEL ASSEMBLY, LOX CONTROL
VALVE, BUTTERFLY

5.2.2 SECOND PART. The second part of the drawing title shall be separated from the first part by a comma and shall be the second line of the title. The second part shall consist of

additional modifiers or modifying phrases as required to complete the identification of an item and distinguish it from similar items that perform the same general functions; for example, modifiers indicating method of operation, pertinent dimensions or size, function, rating, location, etc.

Examples: CABINET, ELECTRICAL EQUIPMENT,
FUEL TRANSFER

PUMP, LOX TRANSFER,
1000 GPM

5.3 RULES

The following general rules apply to all drawing titles and item nomenclature:

a. No abbreviation of any portion of the name (first part) shall be made, except those necessarily used trademarked names (see step d) and the words ASSEMBLY (ASSY), SUBASSEMBLY (SUBASSY), or INSTALLATION (INSTL).

b. Abbreviations may be used in the second part of the nomenclature; however, they shall conform to the requirements in volume I, section II. In general, the use of abbreviations should be avoided.

c. An ambiguous noun or one that designates several classes of items shall not be used alone but shall be used as part of a noun phrase.

Examples	Correct	Incorrect
	JUNCTION BOX	BOX, JUNCTION
	SOLDERING IRON	IRON, SOLDERING
	HEATING ELEMENT	ELEMENT, HEATING
	ANTISEIZE COMPOUND	COMPOUND, ANTISEIZE

d. A trademarked or copyrighted name shall not be used as the noun or noun phrase, unless the technical name is extremely difficult or no other name is available.

Examples	Correct	Incorrect
	FREON 12	DICHLORODIFLUOROMETHANE

e. When an item is neither a container nor a material but its name involves the use of a noun that ordinarily designates a container or a material, a noun phrase shall be used as the basic name.

Examples	Correct	Incorrect
	JUNCTION BOX	BOX, JUNCTION
	CABLE DRUM	DRUM, CABLE
	SOLDERING IRON	IRON, SOLDERING

f. The following words shall not be used alone but may form a part of a noun phrase:

acid	machine
apparatus	mechanism
assembly	mix
assortment	mixture
attachment	oil
compound	outfit
device	plant
element	powder
equipment	shop
fluid	subassembly
group	tackle
instrument	tool
kit	unit
liquid	vehicle

Examples: TOOL KIT
MACHINE SHOP

g. The conjunction "or" and the preposition "for" shall not be used.

h. Parentheses shall not be used to enclose any portion of the drawing title or item nomenclature.

i. The basic name shall describe the item and not the material or method of fabrication. A basic name such as "casting," "forging," "weldment," etc., shall not be used. In lieu of such a name, a noun or noun phrase shall be assigned that indicates what the item is or what it does; for example, BRACKET in the item name "SUPPORT BRACKET."

j. A quick-check method to ensure proper item identification is to read the assigned nomenclature backwards from the last modifier to the next modifier to the basic name.

Example: CABINET, ELECTRICAL EQUIPMENT,
FUEL TRANSFER

would read

FUEL TRANSFER ELECTRICAL EQUIPMENT CABINET

SECTION VI

DRAWING AND PART IDENTIFICATION

6. 1 SCOPE

This section establishes numbering, coding, and identification procedures for engineering drawings and documents referenced thereon, and provides guidelines for identification of parts, materials, processes, and treatments and for reference designations specified on engineering drawings.

6.2 IDENTIFICATION REQUIREMENTS

All engineering drawings shall be assigned identification numbers in conformance with the requirements specified in this section.

6.2.1 COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE. All engineering drawings shall be identified with the CAGE code of the John F. Kennedy Space Center (KSC), NASA. This code number is 22264 and shall be entered on the drawing in the drawing format title block. (See figure 6-1.)

6.2.2 REFERENCED DOCUMENTS. All documents other than Government or non-Government specifications and standards referenced on drawings shall have a document identification number and a CAGE code. These identification numbers shall be placed in a conspicuous location on the drawing. The design organization is responsible for assigning or obtaining document numbers and the CAGE codes for documents used on drawings.

6.2.3 DRAWING NUMBER. A drawing number shall not exceed 15 characters. These characters include numbers, letters, and dashes, with the following limitations:

a. Numbers shall be Arabic numerals. Fractional, decimal, and Roman numerals shall not be used.

b. Blank spaces are not permitted.

c. Symbols, such as parentheses (), asterisk *, virgule /, degree °, plus +, and minus –, shall not be used, except when referencing the Government or non-Government standardization document whose identification contains such a symbol.

d. The CAGE code, the letter designating the drawing format size, and the drawing revision letter are not considered part of the drawing number or part number.

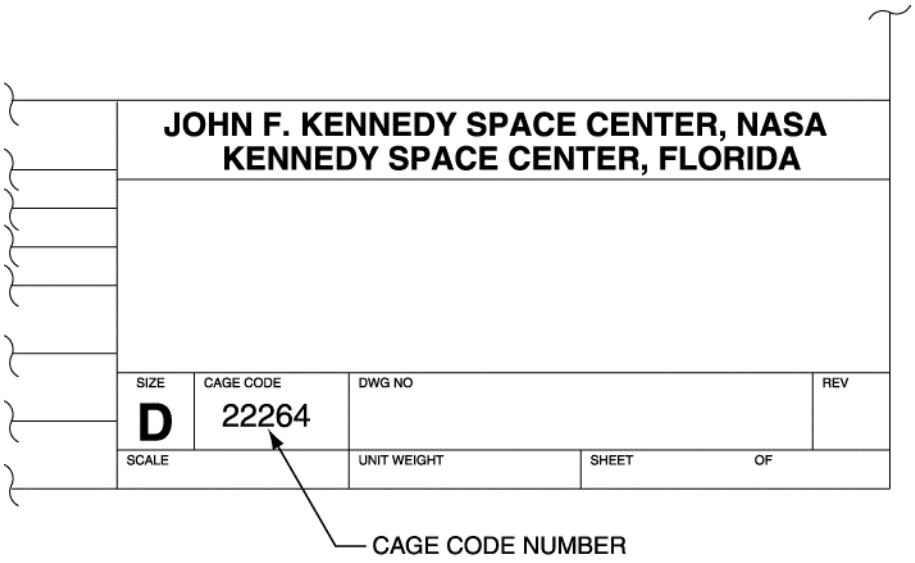


Figure 6-1. NASA KSC CAGE Code Number on Drawings

e. Vendor/manufacturer drawing numbers are exempt from the provisions of this paragraph.

A typical example of a drawing number is 79K12345.

6.2.4 RECORDS. Drawing numbers shall be allocated or assigned by the appropriate documentation center. The documentation center shall keep a complete and accurate record of drawing numbers.

6.2.5 TRANSFERRING DESIGN RESPONSIBILITY TO ANOTHER ORGANIZATION. When the design responsibility for engineering drawings is transferred from one design organization to another, the drawing number, drawing original, and electronic media, if applicable, shall be transferred to the new design organization's documentation center for administration.

6.3 PART NUMBER

A part number shall not exceed 15 characters. This number shall be or shall include the drawing number of the engineering drawing on which the item is described. Where items are described on a tabulated or multi-detail drawing, a unique identification shall be provided by the addition of a suffixed dash number, with the following limitations:

a. The total length of the part number, including the dash number, shall not exceed 15 characters.

b. The dash number shall have the same characteristics as drawing numbers and shall be composed of numbers, letters, or any combination thereof.

c. Suffixed numbers may also be used where only one item is described on a drawing on its initial release.

d. Part numbers shall not include the drawing revision letter or the drawing size.

e. Part numbers shall not be specified on documents that do not define an item. These documents include:

(1) Schematics (electrical/mechanical)

(2) Wiring diagrams

(3) Logic diagrams

(4) Block diagrams

(5 Interface drawings

(6) Installation drawings

(7) Elevation drawings

(8) Connection diagrams

(9) Printed-wiring master pattern drawings

Typical examples of a part number are 79K12345-1, 79K12345-2, and 79K12345-LBV4.

6.3.1 ITEM IDENTIFICATION AND PART NUMBER. Each item (e.g., detail part, assembly, etc.) shall be identified as follows:

a. An item covered by an approved standard and used without alteration shall be identified by the standard part number (such as an MS number for Military Sheet form standards).

b. An item covered by an approved Government specification containing a part identification system and used without alteration shall be identified by that specification identification for the item.

c. All other items shall be identified by a CAGE code and part number on the drawing.

d. Design organizations using items other than their own design without alteration shall identify such items by the original design part number.

e. Items referenced above that are altered shall be identified by a part number established by the design drawing, which depicts requirements for such alterations. The design drawing shall contain the original item identification part number that was applicable prior to the alteration.

6.3.2 REIDENTIFICATION. When items are identified by more than 15 characters or do not meet the other requirements of this section and a design organization has no control over this assignment, the design organization shall not assign a design control number to the item in order to meet the identification requirements of this section.

6.3.3 IDENTIFICATION ON DRAWINGS. Items shall be identified on the field of the drawing by find numbers cross-referenced to the identifying part numbers appearing on the parts list; on a monodetail drawing, the item does not need to be identified on the field of the drawing. When several items are detailed on a single drawing, such as a tabulated, multidetail, or detail assembly or installation drawing, each item shall be assigned a separate identification in accordance with this section. The complete part number shall be shown on drawings and lists; however, on drawings or lists bearing the same drawing number, the dash number only needs to be shown (i.e., the basic number does not need to be repeated). Many commercial parts are identified only by catalog, model, or stock number or by description. Such items may be called out in the description when the item is used without alteration and when no part number exists.

6.3.4 CAGE CODE AND PART NUMBERS. Part numbers identifying items shall also include the CAGE code in the parts list, except when the part is a Government standard or specification item (e.g., KC150K16 or MS9720-6) or is specified in a recognized non-Government standardization document (e.g., ASTM A325M or ASTM A490).

6.3.5 NUMBERING OF RELATED PARTS. Numbers that identify special relationships between parts shall be assigned as follows:

6.3.5.1 Matched Parts Designation. Parts that must be mated and for which replacement as a matched set or pair is essential shall be assigned a single number to designate each matched set or pair. Component parts detailed on matched set drawings, in lieu of separate detail drawings, shall be identified in accordance with this section.

6.3.5.2 Symmetrically Opposite Parts. Symmetrically opposite parts, when feasible, may be described by showing one of the parts, in which case, they shall be identified by adding a dash number after the drawing number (e.g., "79K12345-1 SHOWN" and "79K12345-2 OPPOSITE" shall appear on the drawing; 79K12345 being the basic drawing number). The use of odd dash numbers for the parts shown and even dash numbers for the opposite parts is preferred. As an alternate method, consecutive whole part numbers may be used and so indicated in the title

block. Truly identical parts that can be "reversed" in any position shall carry only one part number.

6.3.5.3 Inseparable Assembly. When two or more pieces are permanently fastened together by welding, riveting, brazing, cementing, or bonding to form an inseparable assembly, the assembly shall be assigned an identifying number. The individual pieces may be assigned part numbers as described in this section and called out on the inseparable assembly.

6.3.6 CHANGES REQUIRING NEW IDENTlFICATION. A new drawing number or part number as described in this section shall be assigned when a part or assembly is changed in such a manner that any of the following conditions occur:

a. Performance or durability is affected to such an extent that superseded items must be discarded for reasons of safety or malfunction.

b. Parts, subassemblies, or complete articles are changed to such an extent that the superseded and superseding items are not interchangeable. This condition is not applicable for unique items or small quantities where all items are under the direct control of the original manufacturer, procuring authority, or the sole using organization, and all items are changed prior to being returned or issued to service. In all cases, all items in service shall be interchangeable.

c. When superseded parts are limited to use in specific articles or models of articles and the superseding parts are not so limited to use.

d. When interchangeable, repairable assemblies contain a noninterchangeable part, the part number reidentification of the noninterchangeable part, its next assembly, and all the progressively higher assemblies shall be changed up to and including the assembly where interchangeability is reestablished.

e. When an item is changed in such a way that it necessitates a corresponding change to an operational, self-test, or maintenance test computer program, the part number identification of the item, its next assembly, and all progressively higher assemblies shall be changed up to and including the assembly in which computer programs are affected.

6.3.7 CHANGES NOT REQUIRING NEW IDENTIFICATION. When a part or assembly is changed in such a manner that the conditions described in 6.3.6 do not occur, the part number shall not be changed. Under no condition shall the number be changed only because a new application is found for an existing part. When an item has been furnished to the Government, the applicable part number shall not be changed unless conditions in 6.3.6 apply. However, when a design organization desires to create a tabulated listing or a standard because of a multiple application of an item, the forgoing need not apply. The superseded drawing will identify the document that superseded it.

6.4 IDENTIFICATION OF MATERIALS, PROCESSES, AND PROTECTIVE TREATMENT

Materials, processes, and protective treatment necessary to meet the design requirements of an item shall be identified on the drawing or parts list by reference to applicable specifications or standards. The applicable type, grade, class, condition, etc., shall be indicated. The revision or amendment symbol of the specification or standard need not be shown. Additional reference to other equivalent specifications is permitted.

6.4.1 GROUP IDENTIFICATION. Group identification involves several different specifications or standards. These specifications and standards may be grouped into a single document that shall be referenced on the applicable drawings or lists of parts by the single document identification. This document shall be part of the set of drawings. Where several processes or protective treatments are involved and a sequence is necessary to meet design requirements, they shall be shown in the order of sequence and be so noted.

6.4.2 OTHER IDENTIFICATION. When materials, processes, and protective treatments are used that cannot be identified adequately in accordance with this section, the drawing or list of parts shall provide additional information for complete identification including the following:

a. Trade names or commercial designations

b. Names and addresses of the producers of the materials or their CAGE codes

c. Chemical composition (where applicable)

d. Physical and mechanical properties in sufficient detail to disclose strength and safety characteristics when required by the design

e. Dielectric properties for electrical insulating materials

6.4.3 FORMULATION IDENTIFICATION. Formulation (chemical constituents of explosives, propellants, pyrotechnics, fillers, etc.) shall be considered and treated as a part and identified in accordance with this section.

6.4.4 BULK MATERIALS IDENTIFICATION. Bulk materials shall be identified in accordance with this section. Where practicable, the quantity or measurement of material shall be included. Separate engineering drawings shall not be prepared for specific quantities of bulk material. When a discrete quantity cannot be identified for an item, use "AR" (as required) in the parts list.

6.5 INTERFACE CONTROL lDENTIFICATION

Drawings that contain features controlled by interface control documents (ICD's) shall be identified with a note specifying the ICD number. Individual features may be identified with a flag note only when special emphasis is necessary.

6.6 REFERENCE DESIGNATIONS

Electrical, mechanical, and electromechanical assemblies, units, or components shall be assigned reference designations in accordance with this section. Reference designations shall be of two types: (1) mechanical find number and (2) electrical reference designator.

6.6.1 MECHANICAL FIND NUMBER. Mechanical find numbers shall be assigned to all mechanical and electromechanical components shown on ground support equipment (GSE) drawings. Mechanical find numbers identifying identical functions in more than one operational location (e.g., MLP 1, MLP 2, MLP 3, or Pad A, Pad B) shall be identified by the same number. When equipment is moved from one operational area to another, the following guidelines shall apply to renumbering of mechanical find numbers:

a. If the number borne by the moved equipment does not duplicate numbers at the receiving complex, the existing number assignment shall be retained.

b. If the moved equipment number duplicates that of existing equipment, a new number shall be assigned and the equipment re-marked accordingly.

c. If the moved equipment is to be used on a temporary basis and is to be returned to its original complex, renumbering and re-marking shall be avoided if possible. Temporary identification tags may be used if new number assignment is necessary.

6.6.1.1 Records. Mechanical find numbers shall be allocated or assigned by the appropriate documentation center. The documentation center shall keep a complete and accurate record of mechanical find numbers.

6.6.1.2 Find Number and Use. The mechanical find number shall consist of the letter A followed by a multidigit number (e.g., A104416, A4455, A6603, etc.). The mechanical find number shall be shown adjacent to the item or component callouts in the field of the drawing on assembly or installation drawings and adjacent to the item or component symbol on a diagram or schematic. When used on drawings in conjunction with electrical reference designators, the mechanical find number shall be enclosed in a "race track" approximately 6 mm (1/4 inch) high (e.g., A2050).

6.6.2 ELECTRICAL REFERENCE DESIGNATOR. Electrical reference designators shall be assigned to all electrical and electromechanical units, assemblies, subassemblies, and components of a GSE electrical system in accordance with MSFC-STD-349. Electrical reference

designators identifying identical functions in more than one operational location (e.g., MLP 1, MLP 2, MLP 3, or Pad A, Pad B) shall be identified by the same number. In some cases, suffixes may be used to define a specific unit, assembly, subassembly, or component in one of two or more areas.

6.6.2.1 Records. Electrical reference designator numbers shall be assigned by the Spaceport Engineering and Technology Directorate (YA), GSE Electrical Design Branch. The YA GSE Electrical Design Branch shall keep a complete and accurate record of electrical reference designator numbers.

6.6.2.2 Electrical Reference Designator Number. Electrical reference designator numbers shall consist of a sequentially assigned unit number, which shall be assigned to a unit within an operational area, and may be followed by an alphanumerical suffix (e.g., 6000, 6673, etc.). Assemblies or subassemblies within a unit shall be identified by a suffix letter A and number (e.g., 6000A1, 6431A4). (See figure 6-2.) Wiring harness or cable assemblies associated with a unit shall be identified by a suffix letter W. A bulkhead plate within a unit shall be identified by a suffix letter B. (See MSFC-STD-349 for additional hardware identifiers.) This method of designation may be expanded as required to permit identification of all components within a unit (e.g., 6503B0lW41, etc.). (See figure 6-3.)

6.6.2.3 Electrical Reference Designator Use. The electrical reference designator shall be shown within or adjacent to the unit, assembly, subassembly, or component callouts in the field of the drawing for fabrication, modification, assembly, or installation and within or adjacent to the item or component symbol on a diagram or schematic. (See figure 6-3.) When used on drawings in conjunction with mechanical find numbers, the electrical reference designator number shall be enclosed within a rectangular block approximately 6 mm (1/4 inch) high (i.e., 6600A1). (See figure 6-3.) Numbers within a unit shall be assigned by the responsible design organization. The entire reference designator number may be abbreviated for subassemblies or components when clarity is not lost. (See figure 6-2.)

6.6.2.4 Cable Assemblies. Electrical cable assemblies shall be identified by a unit number, a suffix letter W, and a number that identifies the specific cable. Cables that connect two units shall be assigned the lower number of the two units. Cables that connect assemblies within a unit shall be assigned the number of the unit. Cables that connect subassemblies within an assembly shall be assigned the number of the assembly (e.g., 6674W15, 6502A7W1, etc.). It is preferred that the W number be designated the same as the connecting jack number, however, this is not mandatory. The method used to assign the suffix number following the W shall be determined by the responsible design organization.

The following guidelines shall apply to the identification of cable ends:

a. Each end of a cable assembly or cable harness shall be identified with a suffix letter P following the cable alphanumerical suffix and a sequence number following the P (e.g., 6673W11P1, 6673W11P2).

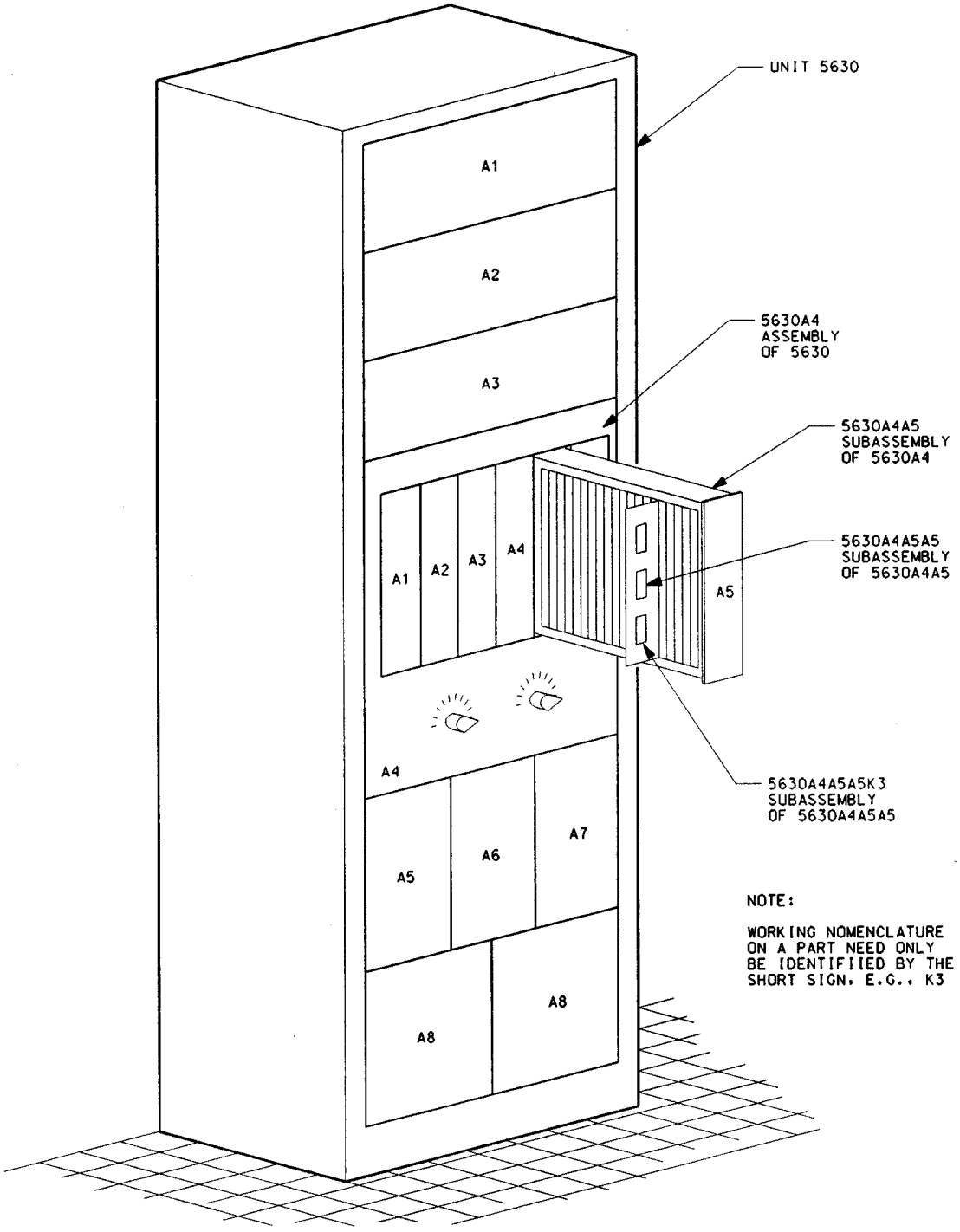


Figure 6-2. Electrical Reference Designation for Assemblies and Subassemblies

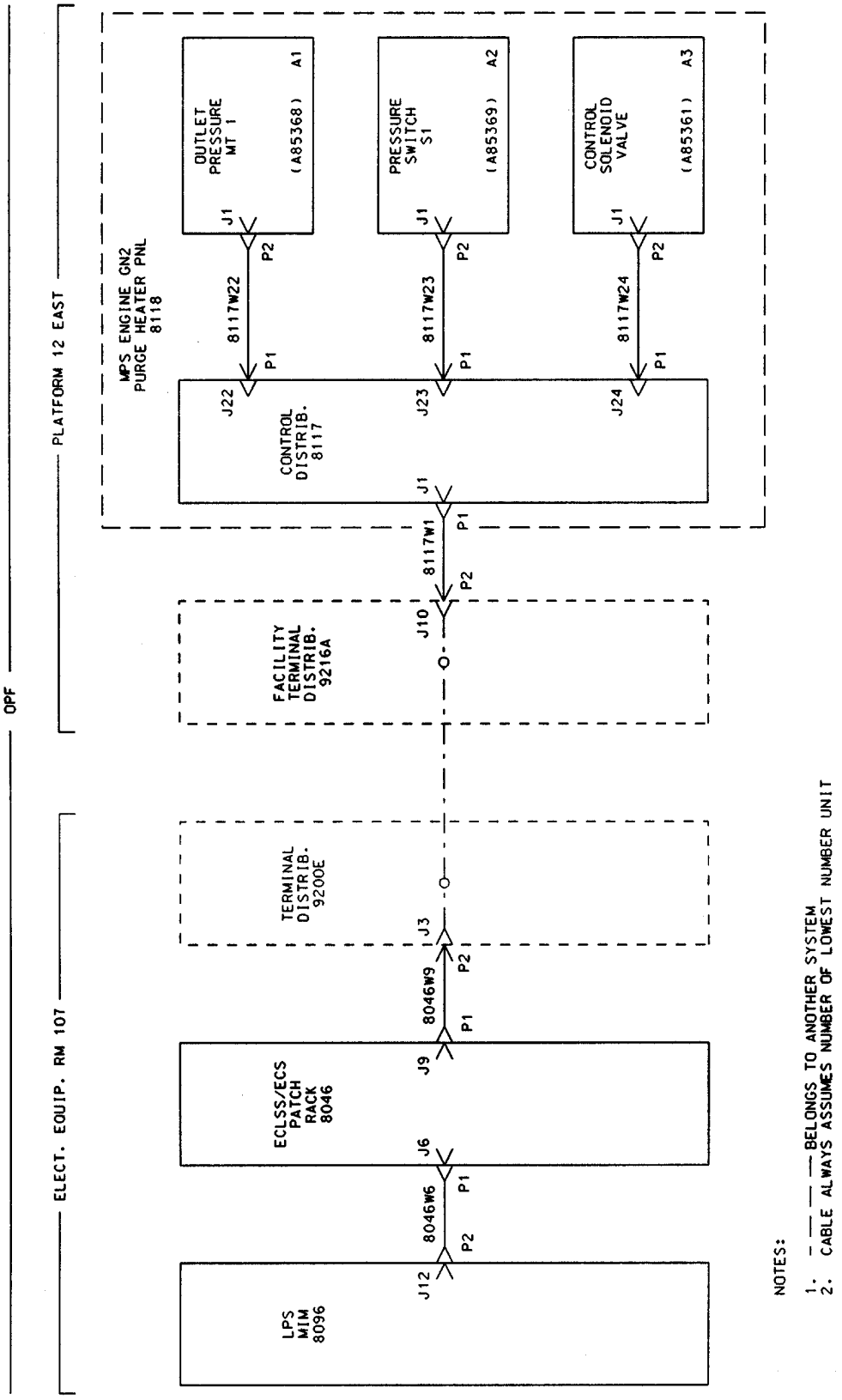


Figure 6-3. Cable Assembly Reference Designators

b. The end of the cable assembly that connects to the unit with the lowest electrical reference designator number shall be designated P1. The unit with the next higher electrical reference designator number shall be designated P2, etc. (See figure 6-4.) For example, the plug at the J17 end of a cable connecting 5107J17 to 9601J1 shall be designated P1 (e.g., 5107W17P1). The plug at the J1 end of the same cable would be P2 (e.g., 5107W17P2).

6.6.2.5 Buses. Bus numbering begins with the power supply bus by assigning an even 100 number. Each time a switchable circuit is passed through, a higher number is assigned within the same 100-number block. Buses shall be treated as special subassemblies. Each bus shall be assigned a reference designation that consists of the number of the unit where the bus originates; the letter D identifies the particular bus connection. A bus may be found in several areas of a system, yet shall continue to retain the reference designation of the unit from which it originates. (See figure 6-5.)

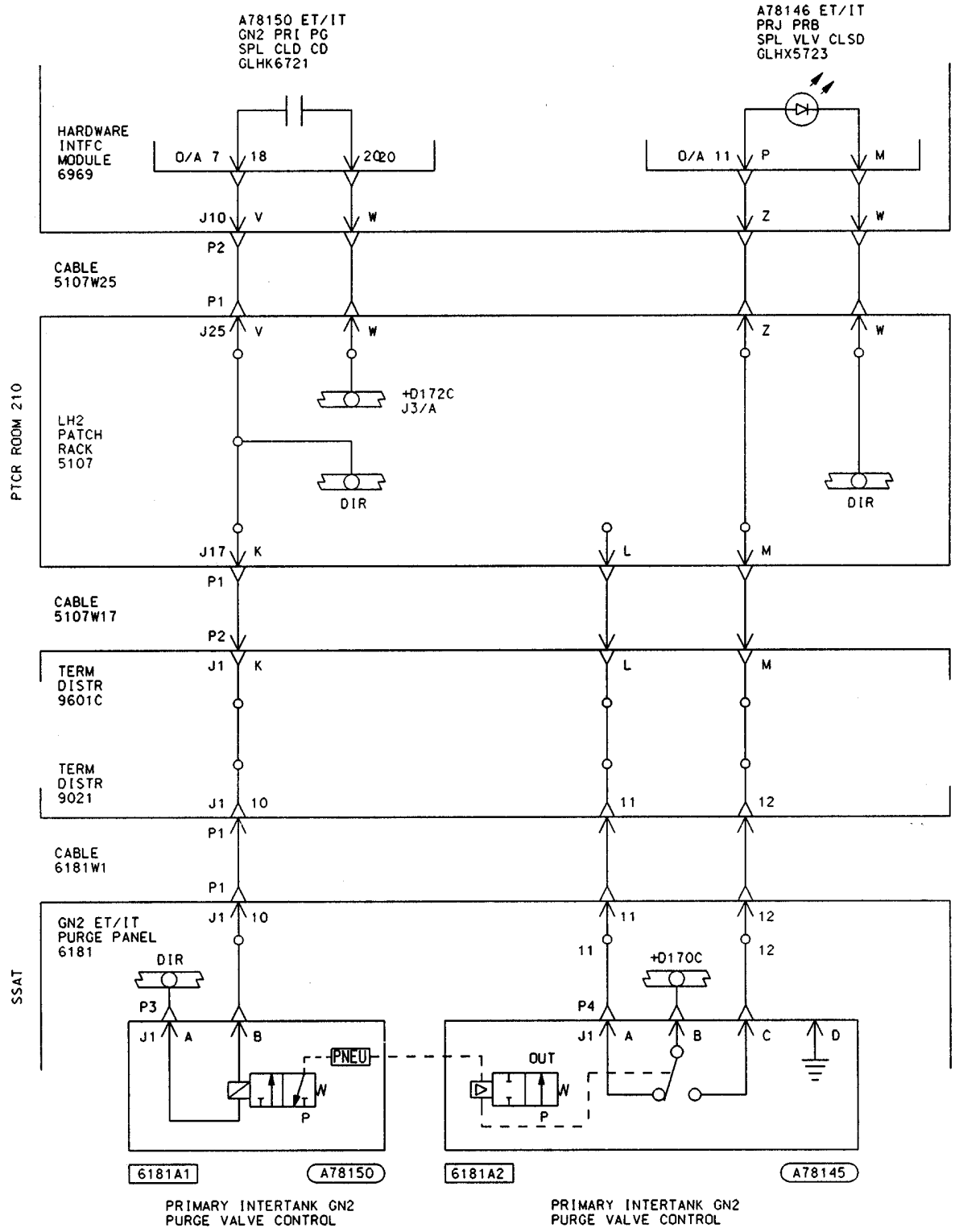


Figure 6-4. Example of Electrical Reference Designators on an Electrical Schematic

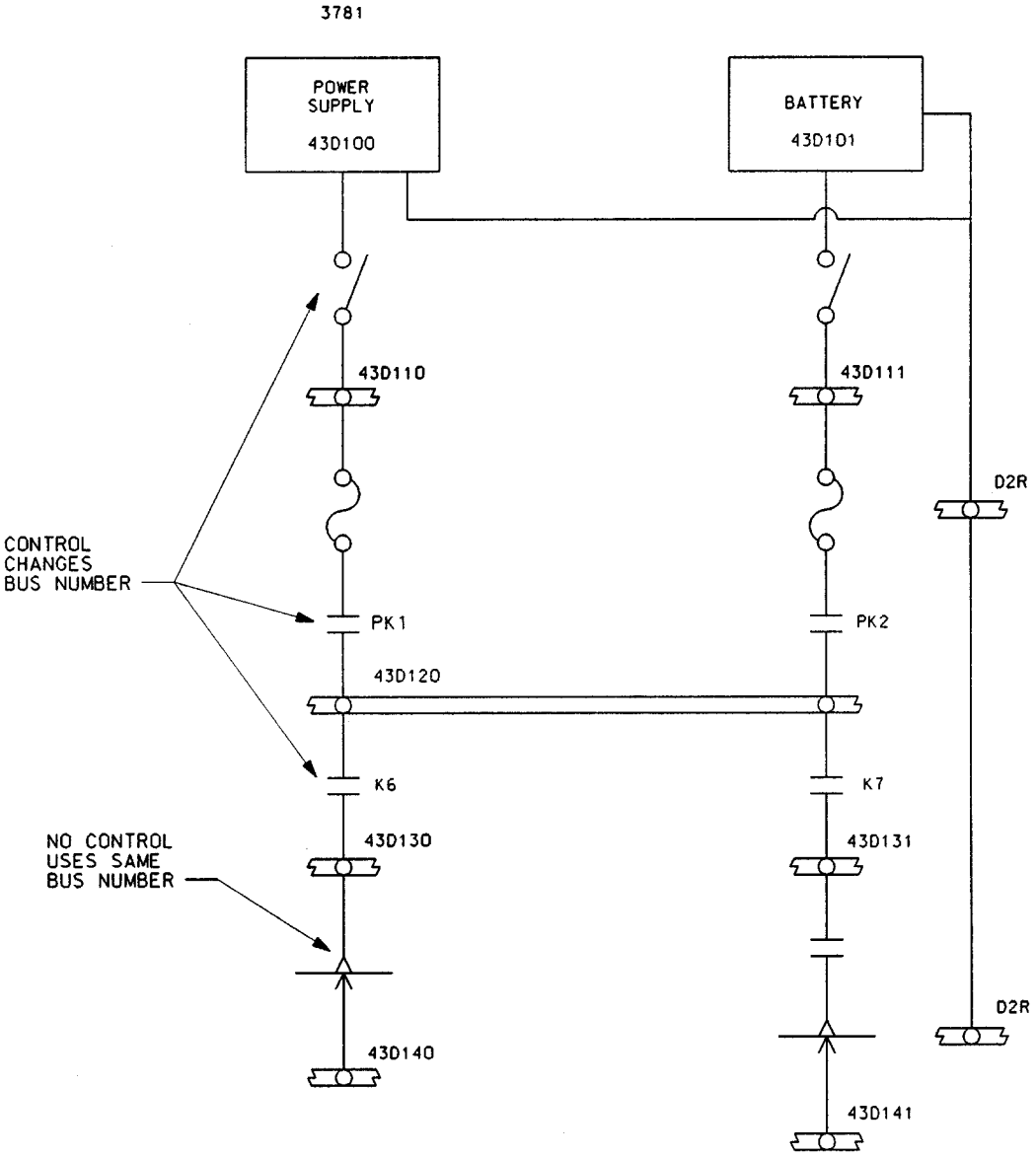


Figure 6-5. Bus Designators

SECTION VII

DRAWING NOTES

7.1 GENERAL

This section establishes the requirements for the preparation and use of notes and brief descriptions of various conditions, with suggested drawings notes to be used on KSC engineering drawings.

7.2 DRAWING NOTE TYPES

Three types of notes shall be used on drawings: (1) general notes, (2) specific notes, and (3) flag notes. General notes contain information that applies to the whole drawing in general. Specific notes shall be used when referring to parts or details on a specific sheet of the drawing. Flag notes shall be used to note information that pertains to a particular item or circumstance. All drawing notes must be clear and specific to avoid misinterpretation. A description of the types of notes and their usage is given in the following paragraphs. Note lettering and spacing guidelines are described in section II (table 2-1).

7.2.1 GENERAL NOTES. General notes are all notes that apply to the entire drawing. All general notes shall be numbered in numerical sequence. A list of all general notes shall be located in the front of the drawing using the format shown in figure 7-1. When a note contains information pertaining to a particular item or circumstance that occurs several times throughout the entire drawing, the note shall be added to the list of general notes and the note number placed within a flag. The corresponding note number shall then be placed within a flag in the applicable field of the drawing (see 7.2.3).

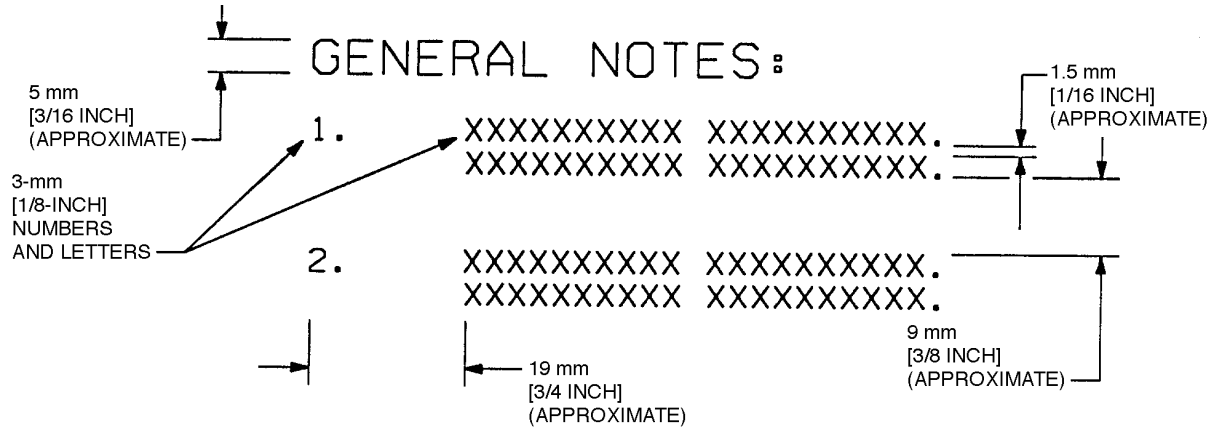


Figure 7-1. Format for List of General Notes

7.2.2 SPECIFIC NOTES. Specific notes shall only be used when they refer to parts or details on a specific sheet of a drawing. Uppercase letters (with the exception of the letters I, O, Q, S, X, and Z, which shall not be used) shall be used to designate specific notes. All specific notes used shall be on the sheet of the drawing to which they apply and shall be listed in alphabetical order. When a note contains information pertaining to a particular item or circumstance that occurs on a sheet, the note shall be added to the specific notes and the note letter placed within a flag. (See figure 7-2.) The corresponding letter shall then be placed within a flag in the applicable field of the drawing.

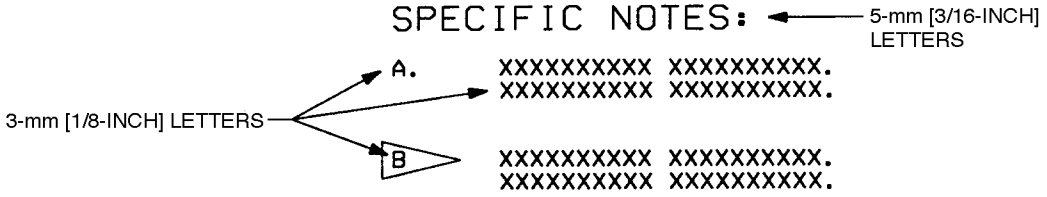


Figure 7-2. Format for List of Specific Notes

7.2.3 FLAG NOTES. When the information in a note pertains to a particular item or circumstance, the applicable note number or letter shall be placed within a triangular flag in the field of the drawing and in the applicable list of notes as described in 7.2.1 and 7.2.2. When a flag is used, it shall be constructed as shown in figure 7-3.

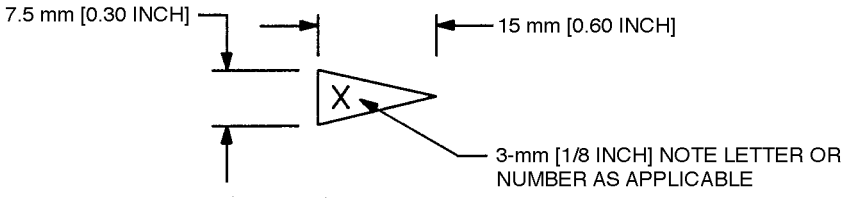


Figure 7-3. Flag Note Size

7.3 LANGUAGE STYLE

The primary consideration on a drawing is its technical essence, presented in language free of vague and ambiguous terms, using the simplest words and phrases that will convey the intended meaning. Inclusion of essential information shall be complete, whether by direct statements or reference to other documents. Consistency in terminology and organization of material will contribute to the drawing's clarity and usefulness. Sentences shall be short and concise. Punctuation must aid in reading and prevent misreading. Well-planned word order requires a minimum of punctuation. When extensive punctuation is necessary for clarity, the sentence(s) shall be

rewritten. Sentences with compound clauses shall be converted into short and concise separate sentences.

7.4 COMMONLY USED WORDS AND PHRASES

Certain words and phrases are frequently used on a drawing. The following rules shall be applied:

a. Reference documents shall be cited as follows:

(1) "conforming to. . ."

(2) "as specified in. . ."

(3) "in accordance with. . ."

In any case, use the same wording throughout the drawing.

b. "Unless otherwise specified" shall be used to indicate an alternative course of action. The phrase shall always come at the beginning of the sentence, and, if possible, at the beginning of the note. This phrase shall be used only when it is possible to clarify its meaning by providing a reference such as another requirement or document.

7.5 USE OF "SHALL," "WILL," "SHOULD," AND "MAY "

a "Shall," the emphatic form of the verb, shall be used whenever a requirement is intended to express a provision that is binding.

b. "Will" may be used to express a declaration of purpose on the part of the Government and is used where simple futurity is required for a provision that will be binding.

c. Use "should" and "may" whenever it is necessary to express nonmandatory provisions. "Should" expresses a strong recommendation and "may" expresses allowance for a provision.

7.6 INDEFINITE TERMS

The terms "and/or," "etc.," "e.g.," and "i.e." shall not be used. On drawings, definite, precise language is imperative. Indefinite terms shall not be used.

7.7 NOTE CONTENTS

Drawing notes are pertinent data given in word form and used to complement the delineation of other given data. The arrangement of the notes shall not be interpreted as an order of precedence or sequence in manufacturing, assembly, etc., unless so specified on the drawing. The following shall be applicable in the preparation/use of notes:

a. General notes shall be numbered consecutively starting with NOTE 1 at the top of the column. Specific notes shall be designated by capital letters and listed alphabetically in a separate column starting with NOTE A.

b. Subparagraphs shall be indented and identified by capital letters in alphabetical order for general notes and by numbers in numerical order for specific notes.

c. Note form requirements shall supplement depiction on drawings where necessary to define the required degree of looseness, tightness, rotation, or extent of travel without bind under spring action, orientation of parts or slots, etc.

d. Filling in voids (open spaces) to accommodate deletions and additions is not required and is not preferred.

e. When a note or flag note is deleted from a drawing, do not delete the identifying number/letter or renumber/alphabetize the notes. Delete the flag if one exists; leave the number/letter visible to indicate its previous use and potential future use and insert "DELETED" in place of the note. A statement shall be included in the revision block of the affected sheet indicating the deletion (e.g., NOTE X DELETED).

f. Specifications and standards shall be listed without revision level or date.

g. All specifications and standards to be used on drawings shall be reviewed for currency, adequacy, applicability, limitations, and determination of need. Options for class, grade, type, form, etc., and any other options required shall be specified.

h. Notes shall not duplicate information specified elsewhere on the drawing.

i. Where two or more statements are being considered for use in a single note, it is usually better to make each statement in a separate note.

j. Information conveyed by notes shall be accurate, complete, and should have only one interpretation.

k. Any required processes for an item shall be specified in the general notes. The note must be complete and define all of the pertinent variables. The flag symbol shall be

used, if necessary, to reference specific locations or restriction of the process, as related to item configuration.

l. Protective finishes shall be specified in the general notes.

m. Drawings shall contain protective finish requirements consistent with repair part provisioning, with application of additional finishes either at subsequent assemblies (next) or at system level (e.g., finish painting or camouflage painting).

n. Torque requirements for threaded fasteners shown on assembly drawings shall be specified as a general note when necessary.

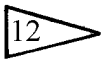
o. General edge/corner break requirements shall be specified as a general note. Requirements for specific feature(s) shall be shown where applicable in the field of the drawing. If applicable in more than one place, the requirement may be identified with the flag symbol method and specified in the general notes.

Examples: (In general notes)

"ALL EDGES AND CORNERS SHALL BE FREE FROM BURRS."

"ALL EDGES AND CORNERS SHALL BE BROKEN 0.005 + 0.010."

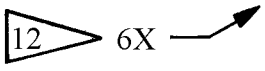
"ALL EXTERIOR CORNERS SHALL BE BROKEN R 0.02 + 0.02."

" 

0.02 MAX EDGE BREAK"

"ALL INTERIOR CORNERS AND EDGES SHALL BE R 0.03 + 0.02."

Examples: (In field of drawing)



(6X)

p. Reference to special drawings or procedures shall be specified as in the following examples:

"FOR SCHEMATIC, SEE DRAWING 79K12345."
"FOR PERFORMANCE REQUIREMENTS, SEE DRAWING 79K12345."

q. Special tools shall be cross-referenced on the drawing of the part and assembly to which the tool applies. Cross-reference shall be by use of a note as in the following example:

"FOR SPECIAL TOOL, SEE DRAWING 79K12345 (REF)."

This cross-reference is required to assure consideration of the tool in the event of a proposed change to the part.

r. The note shall contain only references to the units of measure used on the drawing. If dual dimensions are used, both types of units shall be shown. For example, when using note (8) from table 7-1, only "millimeter/millimeter" shall be shown for metric drawings, and "inch/inch" shown for drawings using U.S. Customary units. For dual-dimensioned drawings, "millimeter/millimeter (inch/inch)" shall be written in the note.

7.8 MATERIAL NOTES

a. Material shall be specified by indicating the basic name, specification, composition, and unified numbering system (UNS) designations (if listed in SAE HS 1086) as a reference, (e.g., "STEEL, ASTM A108: CF1211 (REF: UNS G12110")). The condition, temper, class, type, grade, etc., shall be specified for material that requires subsequent heat treatment.

SAMPLE NOTES:
"STEEL, ASTM A108: CF 1211 THRU 1213 (REF: UNS G12110 THRU G12130)"
"STEEL, MIL-S-16974: 4340 (REF: UNS G43400)"

b. Material requirements and selection shall be listed as a note.

c. Commercial materials shall be specified on drawings only when Government or industry specifications/standards are not available. The commercial material may be defined in specifications prepared in accordance with KSC-STD-P-0001, and that specification shall be used for material requirements.

d. When an item is a casting, it shall be classified in accordance with SAE AMS-STD-2175. A casting classification note, as in the following example, shall be specified on the drawing.

"CASTING CLASSIFICATION. SAE AMS-STD-2175; CLASS I, GRADE B. RADIOGRAPHIC POSITION REQUIREMENTS SHALL BE IN ACCORDANCE WITH DIAGRAM SHOWN."

e. It is recommended that alternative materials also be specified if available.

7.9 CASTINGS

Use the information contained in table 7-1 in the generation of notes on drawings for castings.

Table 7-1. Castings

Description	Drawing Note
(1) Surface finish	Unless otherwise specified, all cast surfaces shall have √ surface finish.
(2) Machining allowance	Material for machining shall be provided on surfaces indicated by finish symbol (√) except when the finish symbol is qualified by AS CAST.
(3) Maximum draft	Maximum draft of (as specified by design) degrees will be permitted provided it does not decrease the section below tolerance.
(4) Cast corners	Unless otherwise specified, all cast external corners to have (as specified by design) radius maximum.
(5) Cast fillets	Unless otherwise specified, all cast fillets to have (as specified by design) radius.
(6) Cast walls	Unless otherwise specified, all cast walls to be ± (as specified by design) thick.
(7) Tolerance, cast angles	Unless otherwise specified, all cast angles to be (as specified by design) degrees.
(8) Tolerance, casting linear dimensions For combined machining and casting drawings where superimposed dimensions are shown.	Unless otherwise specified, the tolerance on casting dimensions shall be ± (as specified by design) millimeter/millimeter (inch/inch) or ± (as specified by design), whichever is greater. Where a machining dimension also defines a casting dimension, the above tolerance applies to the mean dimension. On an unspecified dimension between two cast features, the above tolerance applies to the calculated mean dimension.

Table 7-1. Castings (cont)

Description	Drawing Note
(9) Tolerance, casting linear dimensions For separate raw casting drawings	Unless otherwise specified, the tolerance on casting dimensions shall be ± (as specified by design) millimeter/millimeter (inch/inch) or ± (as specified by design), whichever is greater. On an unspecified dimension between two cast features, the above tolerance applies to the calculated mean dimension.
(10) A six-point tooling system is used for all dimensions	Datum planes shall be defined with respect to six tooling points identified on the drawing. Tooling points, etc., are the planned points on surfaces from which all other points on surfaces are to be checked and machining operations started. All dimensions are with respect to the identified datum planes.

7.10 ELECTRICAL AND ELECTRONIC

Use the information contained in table 7-2 in the generation of notes on drawings for electrical and electronic equipment.

Table 7-2. Electrical and Electronic

Description	Drawing Note
(1) Fabrication	Unless otherwise specified, fabrication of electrical ground support equipment shall be in accordance with KSC-E-165.
(2) Wiring diagram reference Referenced on schematics and assembly drawings.	For wiring diagram, see drawing _____.
(3) Schematic reference Referenced on wiring diagrams and assembly drawings.	For schematic diagram, see drawing _____.
(4) Wiring harness reference Referenced on wiring diagram.	For wiring harness, see drawing _____.
(5) Schematic note Used on schematics instead of repeating the symbols (Ω) and μF.	Unless otherwise specified, resistance is in ohms; capacitance is in microfarads.
(6) Reference designation marking For use on electrical assemblies requiring reference designation markings.	Ink stamp reference designation approximately where shown with 3-millimeter-(1/8-inch-) high letters using A-A-56032 black ink.
(7) Partial reference designation For use when partial reference designations are shown on diagrams and electrical assemblies.	Partial reference designation is shown; for complete designation, prefix with unit number and assembly designations.

7.11 FINISHES, APPLIED

Use the information contained in table 7-3 in the generation of notes on drawings for applied finishes.

Table 7-3. Finishes, Applied

Description	Drawing Note
(1) Anodic finish (Sulfuric acid) For maximum resistance to abrasion on aluminum alloys where dimensional tolerances are ±0.008 millimeter (±0.0003 inch) or more. Do not use for fabricated, spot- welded, or riveted assemblies and parts with nonaluminum cast inserts.	Finish anodic (sulfuric acid) in accordance with MIL-A-8625, Type II all over, except anodic may be omitted from tapped holes.
(2) Anodic finish (chromic acid) For aluminum alloy parts with dimensional tolerances less than ±0.008 millimeter (±0.0003 inch). This finish may be used for fabricated, spot-welded, or riveted assemblies. Do not use for parts with nonaluminum cast inserts. This finish shall not be applied to alloys with nominal copper content in excess of 5.0 percent or when the total content of the alloying elements exceeds 7.5 percent.	Finish anodic (chromic acid) in accordance with MIL-A-8625, Type I all over, except anodic may be omitted from tapped holes.
(3) Anodic finish dyed (sulfuric) acid For maximum resistance to abrasion on aluminum alloys where dimensional tolerances are ±0.008 millimeter (±0.0003 inch)	Finish anodic (sulfuric acid) in accordance with MIL-A-8625, Type II dyed (specified color number) all over, except anodic may be omitted from tapped holes.

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
or more. Do not use for fabricated, spot-welded, or riveted assemblies and parts with nonaluminum cast inserts.	
(4) Anodic finish dyed (chromic acid) For aluminum alloy parts with dimensional tolerances of less than ±0.008 millimeter (±0.0003 inch). This finish may be used for fabricated, spot-welded, or riveted assemblies. Do not use for parts with nonaluminum cast inserts. This finish shall not be applied to alloys with nominal copper content in excess of 5.0 percent or when the total content of the alloying elements exceeds 7.5 percent.	Finish anodic (chromic acid) in accordance with MIL-A-8625, Type I dyed (specified color number) all over, except anodic may be omitted from tapped holes.
(5) Anodic - hard coat (alumilite or Martin) For excess wear and maximum abrasion resistance and for special heat transfer applications on aluminum alloys. Use chromic acid for non-hard-coated surfaces such as aluminum alloys 1100, 3003, 5052, 6061, 6151, and 7075; and cast aluminum alloys 43, 355, and 356. NOTES The following conditions apply to this finish: 1. All threads must be masked. 2. Nonaluminum inserts are not permitted.	Finish hard coat in accordance with MIL-A-8625, Type III, except as noted. (Drawing must indicate surfaces that are not to be coated.)

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
3. Hard coatings may vary in thickness from 0.013 millimeter (0.0005 inch) to more than 0.10 millimeter (0.004 inch) and unless specified shall be nominal 0.05±0.013 millimeter (0.002 ±0.0005 inch) [penetrates 0.025 millimeter (0.001 inch)].	
4. Critical surfaces must show the dimension before and after coating when tolerances closer than ± 0.013 millimeter (0.0005 inch) are required. Hardened surfaces are usually ground or lapped.	
5. Not satisfactory on aluminum alloys having more than 5 percent silicon or more than 7 percent combined total of copper and silicon.	
6. Drawings must indicate surfaces where hardness is required to facilitate the selection of the control surface.	
7. Coating is nonconductive when dry. Breakdown voltage is approximately 1500 volts. Due to inherent crazing of the hard coat, moisture causes a severe electrical breakdown of the coat, reducing electrical resistance to zero.	
(6) Chemical film for aluminum	Finish in accordance with MIL-C-5541, Type 1A.

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
General use for aluminum and aluminum alloys in lieu of anodizing. These chemical films are recommended in preference to anodizing for general protection of aluminum parts that will be painted or for parts that are unpainted but sheltered within other equipment (e.g., unpainted parts inside a nose cone structure). Exposed, unpainted aluminum parts will generally be anodized for better abrasion and corrosion protection. NOTES 1. Use this note where a subsequent paint finish is not required. 2. Use this note where paint is used. 3. Use this note where low electrical resistance is necessary and where subsequent paint finish is not required.	
(7) Chromium plating For wear resistance on ferrous alloys. Minimum thickness is 0.05 millimeter (0.002 inch). Drawing note must specify the thickness required.	Finish chromium plate (specified thickness) thick in accordance with QQ-C-320.

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
NOTE Critical flat surfaces require a radius on edges to prevent buildup at edge. The size of the radius must be determined by trial.	
(8) Chromium plating For wear resistance on ferrous alloy springs and parts having a hardness greater than 35 Rockwell C. Minimum thickness 0.05 millimeter (0.002 inch). Drawing note must specify the thickness required. NOTE Critical flat surfaces require a radius on edges to prevent buildup at edge. The size of the radius must be determined by trial.	Finish chromium plate (specified thickness) thick in accordance with QQ-C-320. Treat to relieve stress and prevent hydrogen embrittlement within 1 hour after plating.
(9) Dichromate treatment For magnesium alloys. NOTE Cast inserts if/when used must be cadmium plated.	Finish in accordance with SAE AMS-M-3171, Type III (Dow 7).
(10) Nickel plating For decorative plating on ferrous alloys.	Finish nickel plate in accordance with QQ-N-290 or ASTM B456.

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
(11) Nickel plating For decorative plating on copper-base alloys.	Finish nickel plate in accordance with QQ-N-290 or ASTM B456.
(12) Passivating corrosion-resistant steel For all types of corrosion-resistant steel containing 12 percent or greater chromium. Individual machine parts and parts fabricated by continuous sealing welds are passivated after finish machining. Parts fabricated by spot or intermittent welding, silver or copper brazing, or riveting are passivated separately before fabrication.	Finish in accordance with ASTM A967.
(13) Phosphate coating Use for coating ferrous alloys other than stainless steel with either a manganese- or zinc-base phosphate.	Finish in accordance with MIL-STD-171.
(14) Phosphate coating Dimensions apply prior to phosphase coating. Use note (13) for parts under 39 Rockwell C. Use note (14) for parts 39 Rockwell C and over.	Finish in accordance with MIL-STD-171, except in Table 1 of MIL-DTL-16232, the treatment for relief of hydrogen embrittlement shall be 1 hour.
(15) Painting of steel structures Finish in accordance with KSC-STD-C-0001. The drawing shall	Finish in accordance with KSC-STD-C-0001, zone (specify zone).

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
specify the zone.	
(16) Painting of steel cabinets and panels Clean in accordance with 4.3 of MIL-STD-171 and paint with specified paint. Drawing must specify color number.	Finish in accordance with 4.3 of MIL-STD-171. Color No. Gray 26440 or 26251 of FED-STD-595.
(17) Painting of aluminum For indoor color applications: Clean in accordance with 4.1 of MIL-STD-171. Specify 7.1.1 anodic (preferred) or 7.3 chemical film. Paint with semi-gloss except use A-A-50557 primer and topcoat with A-A-50570. Drawing must specify treatment, color, and color number.	Finish in accordance with 4.3 of MIL-STD-171 and primer with A-A-50557 and topcoat with A-A-50570. Color No. (specified color number) of FED-STD-595. (Prime color should be different from topcoat color.)
For outdoor applications: Finish in accordance with KSC-STD-C-0001. The drawing must specify the zone.	Finish in accordance with KSC-STD-C-0001, Zone (specify zone).
(18) Clear varnish For cut edges of nonmetallic and insulation materials, including molded parts.	Apply clear varnish in accordance with ASTM D3955 to all cut surfaces.
(19) Touchup finish For unprotected metallic surfaces and damaged finishes. This note should be specified on assembly drawings, where applicable.	After assembly, touch up all exposed unprotected surfaces with an approved finish to match the surrounding surface.

Table 7-3. Finishes, Applied (cont)

Description	Drawing Note
(20) Touchup finish For unprotected metallic surfaces, damaged finishes, and external hardware, such as screw and bolt heads, with touchup paint to match.	After final assembly, unless otherwise specified, all exposed unprotected surfaces and unpainted hardware shall be painted with an approved touchup paint to match the surrounding surface.
(21) Dissimilar metal protection To be used for protection against deterioration between dissimilar metals. One of the following types shall be specified. Type I - Protection for use under severe deteriorating conditions. Type II - Protection for use under moderately severe deteriorating conditions.	Dissimilar metal protection in accordance with MIL-STD-889, Type (specified color number). NOTE Type I deleted.
(22) Grease coating Use for rabbet-fitted parts in aluminum or magnesium alloys where adjustments may be made. For unprotected metallic surfaces such as gear teeth and other surfaces where corrosion protection is not provided. This note should be specified on assembly drawings, where applicable.	(Specified thickness, surface, area, etc.) shall be coated with grease in accordance with MIL-PRF-23827.

7.12 FlNISHES, MACHINED

Use the information contained in table 7-4 in the generation of notes on drawings for machined finishes.

Table 7-4. Finishes, Machined

Description	Drawing Note
(1) Sharp edges	Remove burrs and break sharp edges.
(2) Surface finish	Remove burrs and break sharp edges.
Use when the majority of machined surfaces have the same surface finish.	Unless otherwise specified, all machined surfaces (√ microinches).

7. 13 FORGINGS

Use the information contained in table 7-5 in the generation of notes on drawings for forgings.

Table 7-5. Forgings

Description	Drawing Note
(1) Surface finish	Unless otherwise specified, all forged surfaces (√ specified by design).
(2) Machining allowance	Material for machining shall be provided on surfaces indicated by finish symbol (√) except when the finish symbol is qualified by the words "as forged."
(3) Maximum draft	Unless otherwise specified, maximum draft of (specified by design) degrees will be permitted, provided it does not decrease the section below tolerance.
(4) Forged corners	Unless otherwise specified, all forged external corners to have (specified by design) radius maximum.

Table 7-5. Forgings (cont)

Description	Drawing Note
(5) Forged fillets	Unless otherwise specified, all forged fillets to be (specified by design) radius.
(6) Forged walls	Unless otherwise specified, all forged walls to be (specified by design) thick.
(7) Tolerance, forged angles	Unless otherwise specified, all forged angles to be ± (specified by design) degrees.
(8) Tolerance, forging linear dimensions For combined machining and forging drawings where superimposed dimensions are shown.	Unless otherwise specified, the tolerance on forging dimensions shall be ± (as specified by design) millimeter/millimeter (inch/inch) or ± (as specified by design), whichever is greater. Where a machining dimension also defines a forging dimension, the above tolerance applies to the mean dimension. On an unspecified dimension between two forged features, the above tolerance applies to the calculated mean dimension.
(9) Tolerance, forging linear dimensions For separate raw forging drawings	Unless otherwise specified, the tolerance on forging dimensions shall be ± (as specified by design) millimeter /millimeter (inch/inch) or ± (as specified by design), whichever is greater. On an unspecified dimension between two forged features, the above tolerance applies to the calculated mean dimension.
(10) Six-point tooling system is used for all dimensioning.	Tooling points identified by $\frac{T\|P}{1\|A}$, $\frac{T\|P}{2\|A}$, etc., are the planned points on surfaces from which all other points or surfaces are to be checked and machining operations started. Datum planes shall be defined with respect to six tooling points identified on the drawing. All dimensions are shown with respect to the identified datum planes.

7.14 HEAT TREATMENT

Use the information contained in table 7-6 in the generation of notes on drawings for heat treatment.

Table 7-6. Heat Treatment

Description	Drawing Note
(1) Steel For high-strength, low-alloy steel (e.g., AISI 4340 heat treatment applications).	After rough machining, heat treat to condition [specified by design, (e.g., 1050 to 1250 MPa (150 to 180 ksi))] in accordance with SAE AMS-H-6875. Machine to final dimensions following heat treatment.
(2) Stainless steel For stainless steel (e.g., A286), heat treatment applications.	Precipitation harden in accordance with SAE AMS-H-6875 after final machining.
(3) Nickel alloy For nickel alloy (e.g., 718) heat treatment applications.	Precipitation harden in accordance with appropriate Aerospace Materials Specifications (AMS) (specified by design) and SAE AMS-H-6875 after final machining.
(4) Aluminum alloy (e.g., 6061) For aluminum alloy (e.g., A286) heat treatment applications.	Precipitation harden condition [specified by design (e.g., T6)].

7.15 INSPECTION

Use the information contained in table 7-7 in the generation of notes on drawings for inspection.

Table 7-7. Inspection

Description	Drawing Note
(1) Magnetic particle inspection To detect surface cracks, specify on detail drawings as required. May	Perform magnetic particle inspection in accordance with KSC-SPEC-Z-0013.

Table 7-7. Inspection (cont)

Description	Drawing Note
also be used for magnetic castings and forgings when requested.	
(2) Penetrant inspection To detect surface cracks, specify for use on nonmagnetic materials. Use for particle inspection of Nonmagnetic stainless steel (300 Series) or aluminum.	Perform penetrant inspection in accordance with KSC-SPEC-Z-0013.
(3) Ultrasonic inspection To detect internal defects, specify in detail drawings for smooth surfaces.	Perform ultrasonic inspection in accordance with KSC-SPEC-Z-0013.

7. 16 RIVETING

Use the information contained in table 7-8 in the generation of notes on drawings for riveting.

Table 7-8. Riveting

Description	Drawing Note
(1) Rivet coding For use when rivet coding is required.	Rivet coding in accordance with NAS 523.
(2) Riveting For use when riveting is required.	Rivet in accordance with MSFC-STD-156.
(3) Blind fasteners Use for the installation and inspection of high-strength, pull-type fasteners.	Install fasteners in accordance with NASM 81177.

7.17 THREADS AND THREADED FASTENERS

Use the information contained in table 7-9 in the generation of notes on drawings for threads and threaded fasteners.

Table 7-9. Threads and Threaded Fasteners

Description	Drawing Note
(1) Helical coil inserts For use on drawings requiring tapping for and installation of inserts.	Tap and install inserts in accordance with MS-33537.
(2) Helical coil inserts For use on drawings requiring tapping for and installation of inserts and removal of notched tangs when screw must project through the insert.	Tap and install inserts in accordance with MS-33537 and remove notched tangs after installation
(3) Screw threads (UN and UNR)	Unified inch screw threads per ASME B1.1 (UN and UNR thread form).
(4) Torquing requirements	Torque to (specified by design) joules (inch-pounds).
(5) Locking requirements - flathead screws For locking flathead screws, sizes 10 and smaller, using an adhesive.	Lock flathead screws in accordance with MIL-S-22473, grade (specified by design).
(6) Safety wiring For use on assembly drawing requiring safety wiring.	Safety-wire all drilled-head screws, bolts, etc., after assembly in accordance with NASM 33540.
(7) Pipe threads (taper)	Tapered pipe threads shall be in accordance with SAE AS-7105.

7.18 WELDING, BRAZING, AND SOLDERING

Use the information contained in table 7-10 in the generation of notes on drawings for welding, brazing, and soldering.

Table 7-10. Welding, Brazing, and Soldering

Description	Drawing Note
(1) Carbon steel, low alloy steel, stainless steel, and aluminum alloy welding. For drawings that have this type of material, the weld class (A, B, or C) shall be specified in the note.	Weld in accordance with NASA-SPEC 5004, Class (specify class A, B, or C).
(2) Extra-high-strength steel (EHS) For drawings having EHS. [>620 kPa UTS)] (>90 ksi UTS) quenched and tempered, low-alloy steels. The class of EHS steel shall be identified. The weld type and level of inspection shall be specified.	Weld in accordance with NASA-SPEC-5004, Class (specify class), type (specify type). Class (specify class) inspection.
(3) Stainless steel and Invar pipe For drawings having stainless steel or Invar 36 pipe materials.	Weld in accordance with NASA-SPEC-5004.
(4) Aluminum alloy pipe For drawings having aluminum alloy pipe materials.	Weld in accordance with NASA-SPEC-5004.
(5) Automatic pipe welding For drawings having carbon steel, stainless steel, aluminum, or Invar 36 materials for pipe welding.	Weld in accordance with NASA-SPEC-5004.
(6) Brazing	Braze in accordance with KSC-SPEC-Z-0005.

Table 7-10. Welding, Brazing, and Soldering (cont)

Description	Drawing Note
For drawings having steel, copper, aluminum, nickel, or magnesium alloy brazing.	
(7) Soldering of electrical connections	Solder in accordance with KSC-STD-E-0010.

7.19 MISCELLANEOUS

Use the information contained in table 7-11 in the generation of notes on drawings for miscellaneous entries.

Table 7-11. Miscellaneous

Description	Drawing Note
(1) Drawing terms and tolerances For use on most detail and assembly drawings where matching is required. Do not use on vendor control-type drawings (e.g., specification control, source control, etc.).	Drawing terms and tolerances in accordance with ASME Y14.5M.
(2) Inactive drawings For drawings that have become inactive. The note should be placed over or adjacent to the drawing title block using approximately 6-millimeter-(1/4-inch-) high letters.	Inactive for new design.
(3) Liquid locking compound For threaded parts or closely fitted metal surfaces. For design and usage data, see MIL-S-22473 and paragraph 6.1.	Any primer and sealing compound to (specify surface, part, etc.) in accordance with MIL-S-22473, Grade (specify grade).

SECTION VIII

DRAWING RELEASE AND CONTROL

8.1 SCOPE

This section defines the requirements for the official release and control of the John F. Kennedy Space Center (KSC) engineering drawings. The documentation release process shall be used to record the official approval of engineering drawings and to obtain the authorization to reproduce, distribute, microfilm, implement, or otherwise utilize the official engineering data contained within the drawings.

8.2 DOCUMENTATION RELEASE AUTHORIZATION FORM

The Document Release Authorization (DRA) form (KSC Form 21-68) or an electronic controlled release equivalent to the DRA shall be used to document the official release of engineering drawings and to document official revisions/changes made to the drawings after their initial release. The detailed procedure for preparation of the DRA shall be in accordance with KDP-KSC-P-1537.

8.3 DRAWING RELEASE APPLICATION

Drawing release by DRA or an electronic equivalent shall apply to the following types of drawings:

a. All drawing types specified in this document

b. Engineering orders (EO's)

c. Vendor drawings

d. Shop drawings

e. Sketches

f. Preliminary drawings

8.4 PRELIMINARY RELEASE

Engineering drawings that are incomplete shall be released only by a preliminary release. When it is deemed advisable to provide advance information prior to the completion of a drawing, the drawing may be released in a preliminary form (for example, preliminary drawings are provided for design reviews).

8.5 PRELIMINARY RELEASE MARKING

All drawings released as preliminary drawings shall be identified as such so they will be readily recognized as being incomplete. Each drawing sheet that is released as a preliminary release shall be identified in the lower right-hand corner above the title block.

The preliminary identification shall be made by indicating the level of completion and the date within a cloudlike marking.

Examples:

8.6 FINAL RELEASE

A final release shall include only those drawings that are complete and ready for implementation, procurement, or utilization in the field.

8.7 DRAWING REVISION/CHANGE RELEASE

A drawing revision/change release shall be made for drawings that have been revised or updated. A drawing revision/change release may also include EO's. Drawing revisions and EO's shall be prepared in accordance with this manual.

8.8 RELEASE RECORDS

Release records shall be recorded, maintained, and filed by the documentation center. Detailed procedures for maintaining release records of engineering drawings shall be in accordance with documentation center procedures.

8.9 DRAWING CONTROL

Drawing control shall be maintained by the appropriate documentation center. When not in use, original released drawings shall be retained by the appropriate documentation center. Detailed procedures for the removal of original drawings from and their return to the documentation center shall in accordance with documentation center procedures.

8.10 DUPLICATE ORIGINALS

Duplicate original drawings shall not be prepared for the purpose of maintaining duplicate records. Preparation of duplicate originals shall be for the following purposes only:

a. Establishing a new original drawing to replace an existing drawing that has become worn or is otherwise not maintainable as an original. In this case, the original from which the duplicate original was made shall be voided and destroyed by the documentation center upon verification of the duplicate original.

b. Providing a base drawing to serve as a point of departure upon which changes can be made to produce a new, uniquely identified original drawing. In this case, the original drawing and the new original drawing shall be separately maintained thereafter.

8.11 DRAWING RECORD

The drawing record shall be the official configuration of a drawing. A drawing record shall be made of all released drawings. The drawing record shall consist of microfilm in accordance with American National Standards Institute/Association for Information and Image Management (ANSI/AIIM) MS 32 or ANSI/AIIM MS 5. Current and history drawing records shall be retained by the documentation center in accordance with documentation center procedures.

SECTION IX

DRAWING CHANGES AND REVISIONS

9. 1 SCOPE

This section establishes the methods for making, identifying, and recording changes and revisions to John F. Kennedy Space Center (KSC) aerospace and ground support equipment (GSE) engineering drawings.

9.2 CHANGE METHODS

Any changes to engineering drawings shall be recorded by Engineering Order (EO) or drawing revision. Changes made by EO's should be incorporated into the drawing when the drawing is revised. EO changes will be used as an alternate method of making drawing changes only when a revision to the drawing is not feasible.

9.2.1 CHANGES BY EO. An EO may be used to change released engineering drawings, specifications, and other types of operations and maintenance documentation. An EO shall be used to change an engineering drawing only when it is impractical to revise the drawing. When an EO is released, it shall become a permanent part of the drawing to which it is applicable. Any change required to correct errors on a released EO shall require the preparation of a new EO. A new EO may cancel a preceding EO in its entirety only if no other subsequent EO's are affected by the cancellation. A portion of an EO cannot be cancelled. All EO's shall be accounted for in the drawing revision block at its next revision release up to and including the last released. An EO against one drawing number shall not be incorporated in another drawing number.

9.2.1.1 Accounting for EO's in Revision Blocks. All EO's since the last revision shall be accounted for on sheet 1 at the next revision. The following terms and definitions are the only accepted methods of documentation for accounting for EO's on sheet 1 of the drawing:

All EO's that are incorporated into the drawing shall be listed as “INC” or “incorporated.”

All EO reservations that are cancelled and will not be released shall be accounted for as "Not used."

All EO's that have been released but have been cancelled by revision or subsequent EO shall be listed as "Cancelled."

Outstanding EO's that are not incorporated shall be listed as "Not Incorporated."

Reserved EO's that fall within the range of EO's being accounted for must also be accounted for in the following format: “EOXX, EOXX are reserved.”

9.2.1.2 EO Format. An EO shall be prepared on KSC Form 21-34 (figure 9-1). KSC Form 21-34A (see figure 9-2) may be used for continuation sheets when necessary. Other forms of documentation may also be used as continuation sheets, including computer printouts or full-size drawing sheets (e.g., F-size drawing format). All continuation sheets shall contain the EO number and the sheet number of the EO package. Continuation sheets that are B-size through F-size drawing formats shall have the title block x-ed out and the EO number and sheet number enclosed within a box above the title block.

9.2.1.3 Preparation of the Engineering Order (KSC Form 21-34). The Engineering Order form (see figure 9-1) shall be completed (utilizing black ink or drafting lead) in accordance with the following instructions.

Block No.	Block Title	Instructions
1	ENGINEERING ORDER NUMBER	Obtain the EO number from the documentation center that has release authority. The EO number shall consist of the drawing number preceded by the letters "EO" and a sequence number followed by the drawing number. For example, the first EO for drawing number 79K12345 would be numbered EO1-79K12345; the second EO would be numbered EO2-79K12345, etc. Enter the EO number in block 1 of the form and on each continuation sheet of the EO.
2	SHEET_____OF_____ SHEETS	Number each sheet of an EO sequentially beginning with number 1. Enter the sheet number and the total sheet number in block 2 of the form.
3	EFFECTIVITY	Specify the launch complex or facility and the vehicle to which it applies (e.g., LC-39, Shuttle; VPF-TDRS).
4	DISPOSITION OF OLD PARTS	
	SCRAP:	Check to indicate that removed parts are to be excessed.

ENGINEERING ORDER

1. ENGINEERING ORDER NO. (Prefix followed by Dwg. No.)

2. SHEET OF SHEETS

3. EFFECTIVITY (Facility & Vehicle)

4. DISPOSITION OF OLD PARTS (Check one)
☐ SCRAP ☐ REWORK ☐ USE ☐ NOT APPLICABLE

5. TITLE OF DRAWING

6. REASON FOR CHANGE

7. DESCRIPTION OF CHANGE

SAMPLE

ACTION	QTY	FIND NO.	MFR. CODE	PART NO.	DESCRIPTION	STOCK SIZE	MATERIAL SPEC

PARTS LIST

8. **SIGNATURES**

REQUESTER	DATE	DRAFTSMAN	DATE
STRESS	DATE	ENGINEER	DATE
CHECKER	DATE	APPROVED BY	DATE

KSC FORM 21-34 (REV. 9/90) PREVIOUS EDITIONS ARE OBSOLETE

Figure 9-1. Engineering Order (KSC Form 21-34)

ENGINEERING ORDER
CONTINUATION SHEET

1. ENGINEERING ORDER NO. (Prefix followed by Dwg. No.)

2. SHEET OF SHEETS

7. DESCRIPTION OF CHANGE (CONTINUATION)

SAMPLE

ACTION	QTY	FIND NO.	MFR. CODE	PART NO.	DESCRIPTION	STOCK SIZE	MATERIAL SPEC

PARTS LIST

KSC FORM 21-34A (REV. 9/90) PREVIOUS EDITIONS ARE OBSOLETE

Figure 9-2. Engineering Order Continuation Sheet (KSC Form 21-34A)

Block No.	Block Title	Instructions
	REWORK:	Check whenever any part that is existing on the documentation is to be modified or reworked and is intended to remain in use or be saved for future use.
	USE:	Check when all parts in the engineering affected by the EO are to be used as is.
	NOT APPLICABLE:	Check when changes are to the engineering, documentation only.
5	TITLE OF DRAWING	Enter the exact title of the drawing (not including the subtitle) as it appears on the first sheet unless the title has been changed by a previous EO. Then enter the exact title as changed by that EO.
6	REASON FOR CHANGE	Indicate the reason or purpose for the change to the drawing. This block may also include the change authorization number, if applicable, such as the Engineering Support Request (ESR) number, Problem Report (PR) number, Configuration Control Board Directive (CCBD) number, or other pertinent information that may be referred to for additional rationale or justification for the change. In addition, the program model number and baseline may also be added.
7	DESCRIPTION OF CHANGE	Provide a complete and exact description of all changes to the drawing. The change description shall be clear and concise using text and sketches. A brief summary of the changes included in the EO is recommended to precede the detailed description. The following practices shall be used for describing the changes: (a) When practical, each change in the EO shall be sequentially numbered in the order in which the areas of the drawing being changed appear in the drawing. (b) Each change location within the draw-

Block No.	Block Title	Instructions
		ing shall be identified by sheet number and, if applicable, zone identification.
		(c) The drafting methods and practices used in preparing the drawing being changed shall always be followed in the EO to the maximum extent possible.
		(d) The WAS AND IS method may be used to define the change. The use of information enclosed in a cloudlike marking that indicates the area of the change is acceptable when appropriate.
		(e) New find numbers, note numbers, or new view, elevation, section, or detail identification letters shall not be assigned in an EO. The numbers and letters shall be assigned at the time of EO incorporation into the drawing. When new numbers/letters are required within the EO, a notation such as *1, *2, or *A, *B, etc., along with a note *ITEM NUMBER TO BE ASSIGNED AT TIME OF EO INCORPORATION shall be used.
	PARTS LIST	An abbreviated parts list shall be used to indicate changes in parts or materials required for the EO. Complete the following block as applicable:
		ACTION — Enter ADD or DEL to add or delete the part or item.
		QTY — Enter the quantity of parts that is added or deleted.
		FIND NO. — Enter the find

Block No.	Block Title	Instructions
		number of the part that is added or deleted.
		MRF CODE — Enter the CAGE code for the part.
		PART NO. — Enter the part number of the part.
		DESCRIPTION — Enter a description of the part.
		STOCK SIZE — Enter the stock size of the part.
		MATERIAL SPEC — Enter the material spec for the part.
8	SIGNATURES	Obtain the following signatures (in black ink or drafting lead) or approval indicators, as required, to approve the EO.
		(a) REQUESTER. The name, organization, and department number of the person who is requesting the change to the engineering document, and the date.
		(b) STRESS. If stress analysis or material analysis is required, include the signature, organization, and department number of the responsible stress or materials analysis engineer, and the date.
		(c) CHECKER. The signature or approval indicator, organization, and department number of the designated engineering checker for changes made to the document, and the date.
		(d) DRAFTSMAN. The signature or ap-

Block No.	Block Title	Instructions
		proval indicator of the draftsperson who drew the EO and the date. If the engineer making changes to the engineering document is the person who drew the EO, that person's name shall be printed in this block.
		(e) ENGINEER. The signature or approval indicator, organization, and department number of the engineer who requested the EO from the documentation center and who is responsible for the content of the EO, and the date. Additionally, if an in-house tracking number is used, it may be placed on the EO in this block only.
		(f) APPROVED BY. The signature or approval indicator, organization, and department number of the approving management, and the date.

9.2.1.4 Preparation of the Engineering Order Continuation Sheet (KSC Form 21-34A). The Engineering Order Continuation Sheet (see figure 9-2) shall be completed (utilizing black ink or drafting lead) in accordance with the following instructions.

Block No.	Block Title	Instructions
1	ENGINEERING ORDER NUMBER	Enter the EO number followed by the drawing number (e.g., EO1-79K12345).
2	Sheet_____ of _____Sheets	Enter the sheet number on each sheet and total number of sheets in the EO on the last sheet (e.g., sheet 6 of 6 sheets).
7	DESCRIPTION OF CHANGE (CONTINUATION)	Enter a continuation of change description.
–	PARTS LIST	Use the parts list to continue changes in parts or materials. The parts list shall be completed in the same manner as KSC Form 21-34.

9.3 REVISION METHODS

Revisions shall be made by erasure, addition of information, or by redrawing. The "crossing-out" method of revision shall not be used.

9.3.1 REVISION DRAWING PRACTICES. When revising an existing drawing, the graphic symbols, designations, lettering style and size, material and method of application, and drawing practices used in creating the original drawing shall be followed for changes/revisions, unless otherwise directed by the responsible design organization.

9.3.2 CHANGE IN DIMENSIONS. In general, any change in a dimension of a part shall also be made to scale on the affected portion of the drawing; however, it is permissible to leave the drawing unchanged when the new portion of the part is not noticeably different from the original.

9.4 RECORDING REVISIONS ON DRAWINGS

Each revision shall be recorded in the revision block of the drawing at the time the drawing is revised. The revision block format on drawings shall be as identified in section II. To provide for future revisions, the space beneath the revision block shall be left blank on the initial release of the drawing. On D-size and larger drawing formats, a minimum of 90 millimeters (mm) (3.5 inches) of blank space should be provided under the revision block on the format. Instructions for completing the revision block are contained in the following paragraphs. (See figure 9-3.) Previous revision block descriptions shall not be changed. To correct previous revision information, so state in the current revision description.

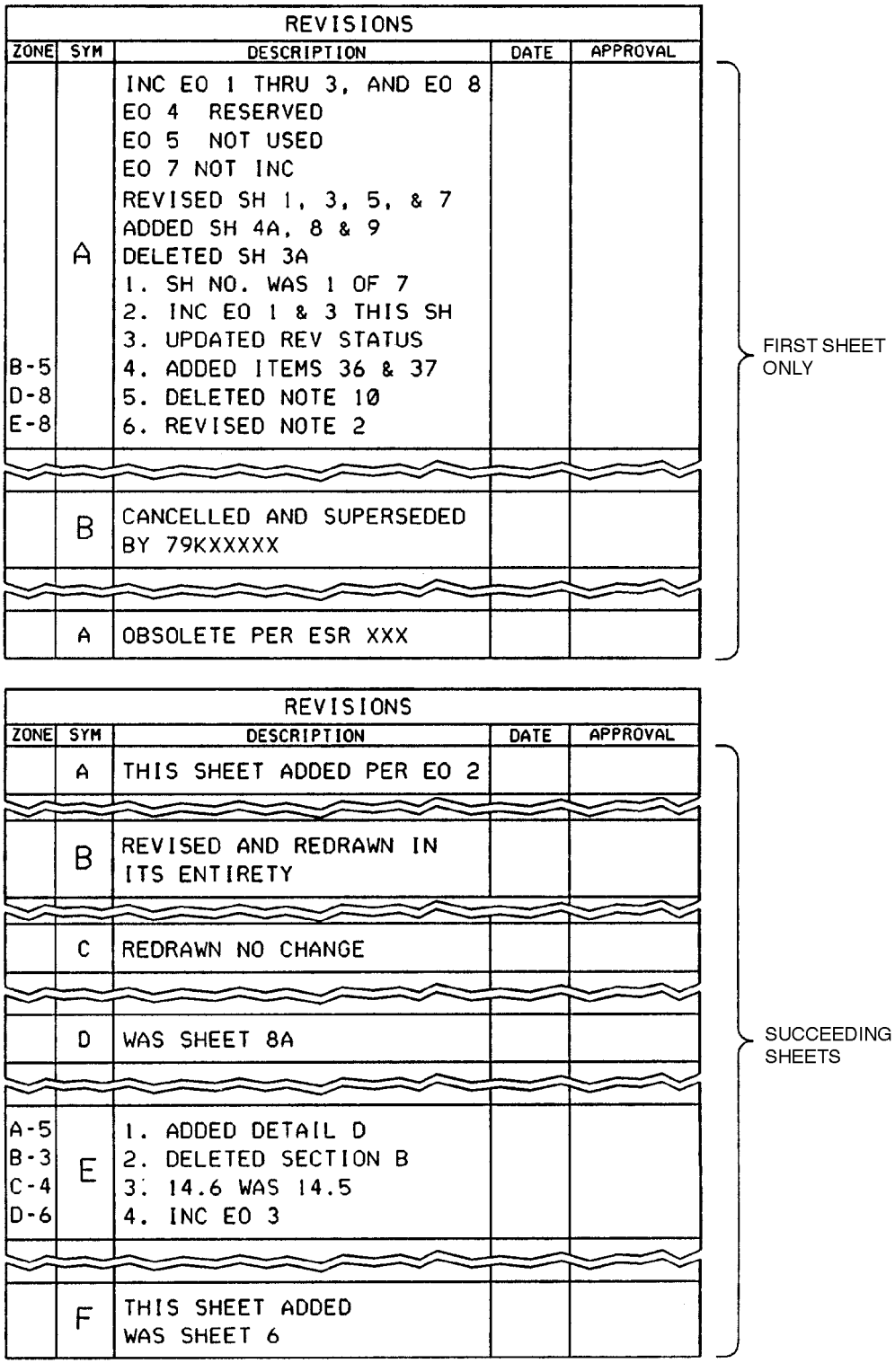
For drawings with extensive revision histories, when limited by the allocated space, revision data for no more than the current and the immediately preceding revision shall be required. In no case shall additional sheets be added to the drawing solely for the purpose of recording revision data.

9.4.1 ZONE. When changes are recorded by zoning, the zone in which each change is made shall be entered in the ZONE column on the same line as the description of the change.

9.4.2 REVISION LETTER. The identifying letter pertaining to the particular revision being recorded shall be entered in the SYM column.

9.4.3 DESCRIPTION. Brief statements shall be used to explain revisions. Pictorial sketches and symbology shall not be used. Reference to a revision authorization document shall not be required in the description.

9.4.3.1 Sheet 1 of Drawing. All EO's incorporated throughout the drawing at the current revision shall be listed. Not-used or canceled EO's shall also be listed. Sheets revised, revised and redrawn, added, or deleted shall be explicitly listed in separate respective statements (i.e., “sheets 1-3, 3A, 4-7,” not sheets 1-7). Direct revisions affecting sheet 1 shall have a brief description and be sequentially numbered. (See figure 9-3.)



REVISIONS

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
B-5 D-8 E-8	A	INC EO 1 THRU 3, AND EO 8 EO 4 RESERVED EO 5 NOT USED EO 7 NOT INC REVISED SH 1, 3, 5, & 7 ADDED SH 4A, 8 & 9 DELETED SH 3A 1. SH NO. WAS 1 OF 7 2. INC EO 1 & 3 THIS SH 3. UPDATED REV STATUS 4. ADDED ITEMS 36 & 37 5. DELETED NOTE 10 6. REVISED NOTE 2		
	B	CANCELLED AND SUPERSEDED BY 79KXXXXX		
	A	OBSOLETE PER ESR XXX		

FIRST SHEET ONLY

REVISIONS

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
	A	THIS SHEET ADDED PER EO 2		
	B	REVISED AND REDRAWN IN ITS ENTIRETY		
	C	REDRAWN NO CHANGE		
	D	WAS SHEET 8A		
A-5 B-3 C-4 D-6	E	1. ADDED DETAIL D 2. DELETED SECTION B 3. 14.6 WAS 14.5 4. INC EO 3		
	F	THIS SHEET ADDED WAS SHEET 6		

SUCCEEDING SHEETS

Figure 9-3. Examples of Typical Revision Recordings

9.4.3.2 Succeeding Sheets. EO incorporations shall be indicated in the description column of each sheet affected by the EO. Direct revisions shall have a brief description and be sequentially numbered. (See figure 9-3.) Additional revision descriptions for multiple-sheet drawings are described in 9.6.

9.4.4 REVISION DATE. The method of specifying the revision date should be numerical by year-month-day (yy/mm/dd).

9.4.5 APPROVAL. The approval of the revision shall be indicated by the initials, name, or the signature of the authorized design organization representative entered in the APPROVAL column. CAD-prepared drawings may be signed for each revision. Subsequent revisions of CAD-prepared drawings may show printed initials/names in place of the original signatures on previous revisions.

9.4.6 SEPARATING REVISIONS. Each revision shall be separated from the next revision by a horizontal line.

9.5 REVISION IDENTIFICATION

Revisions of drawings shall be designated by letters alphabetically. The locations of the revisions on the drawing shall be identified through the use of revision symbols in the field of the drawing and a description in the revision block on the drawing. The location of the revision may also be enclosed within a cloudlike marking when special emphasis is required.

9.5.1 REVISION LETTERS. Uppercase letters shall be used in alphabetical order, excluding the letters I, O, Q, S, X, and Z to identify each sequential revision to a drawing. When revisions to the drawing are numerous enough to exhaust the alphabet, the revision following Z shall be identified as AA, AB, AC, etc., excluding the letters I, O, Q, S, X, and Z. If the AA to AZ sequence should be exhausted, the next sequence shall be BA, BB, BC, etc., omitting the letters I, O, Q, S, X, and Z. The basic release (initial issue) of a drawing shall not be assigned a revision letter. Letters shall not be skipped in the applicable revision letter sequence.

When multiple changes are incorporated in a drawing at the same time, all of the changes shall be identified by the same revision letter. The changes shall be sequentially numbered to permit ready identification of each specific change. In such cases, the appropriate sequence number will appear as a suffix to the revision letter in the revision symbol (see figure 9-4) and be identified in the description in the revision block of the drawing.

Figure 9-4. Revision Symbol

9.5.2 REVISION SYMBOLS. A revision symbol shall consist of the applicable revision letter and a change suffix number (when required) enclosed in a 10-mm- (3/8-inch-) diameter circle (see figure 9-4). Revision symbols shall be located as near as practical to the change in the field of the drawing. Revision symbols shall not be used on printed-wiring drawings or on other types of drawings when their use may adversely affect clarity. When multiple changes are involved in one area of a drawing to the extent that use of separate revision symbols would crowd the drawing, a single revision symbol may be used to identify the changes, provided sufficient information is included in the revision block. For each subsequent revision, the previous revision symbols may be removed from the field of the drawing.

9.6 REVISION OF MULTIPLE-SHEET DRAWINGS

Concurrent changes made upon any or all sheets of a multiple-sheet drawing shall be identified on each sheet revised by the same revision letter. Each sheet revised by a specific revision shall be indicated in the revision block on sheet 1 of the multiple-sheet drawing. (See figure 9-3.) The revision status shall also be indicated on the drawing index or revision status summary (if existent in drawing). (See figure 9-5.) The revision status shall be provided on the first sheet or the index sheet of a drawing.

A revision to any sheet requires an upgrade in the revision level of that sheet and sheet 1; therefore, the revision of sheet 1 represents the revision level of the entire multiple-sheet drawing. No sheet shall contain a revision level higher than that shown for sheet 1.

9.6.1 ADDING SHEETS. Added sheets constitute a revision to the drawing. This revision shall be entered both on the added sheet and on sheet 1.

9.6.1.1 Inserting New Sheets. Additional sheets inserted between existing sheets shall not require the renumbering of all subsequent sheets, which would require revising sheets with interconnect ballouts or cross-reference of details, sections, etc. The added sheet shall be numbered the same as the previous sheet number with the addition of the letter A (e.g., 26A). If additional added sheets immediately follow an added sheet, they shall also be numbered by adding letters alphabetically to the previous sheet number (e.g., 26B, 26C, etc.). If additional sheets are inserted between previously added sheets (e.g., between 26A and 26B), new sheets shall be numbered with the same alphanumeric sheet number as the previous page with the addition of numbers in consecutive order (e.g., 26A, 26A1, 26A2, etc.). Sheet number lettering shall comply with the same practices specified for revision letters in 9.5.1 (the letters I, O, Q, S, X, and Z shall not be used). The sheet number recordings on the first and last sheets of the drawing shall remain unchanged. The title block of a new sheet shall reflect the date the new sheet was approved and new signatures, in accordance with section II. The revision description on the new sheet should read THIS SHEET ADDED or THIS SHEET ADDED PER EO-XX, as appropriate. For example (see figure 9-6), a 5-sheet drawing package has a sheet 2A inserted. Sheet 1 reads SHEET 1 OF 5 and sheet 5 still reads SHEET 5 OF 5, even though the total number of sheets is 6. The revision description on sheet 2A reads THIS SHEET ADDED.

DRAWING INDEX		
SHEET	REV	SHEET TITLE
1	A	COVER SHEET
2	A	LIST OF MATERIAL
3		LIST OF MATERIAL
4	A	LIST OF MATERIAL/NOTES
5		MAIN TRACK ASSEMBLY
6	A	TUBE ASSEMBLY RH DETAIL
7	A	TUBE ASSEMBLY LH DETAIL
8		MAIN TRACK ALIGNMENT
9		LIMIT SWITCHES AND HARDSTOPS
10	A	REMOVEABLE SECTION CONNECTION
11		TUBE *1 & *3 RH DETAIL
12		TUBE *4 & *6 RH DETAIL
13		TUBE *1 & *3 LH DETAIL
14		TUBE *4 & *6 LH DETAIL
15	A	TUBE *2 & *5 DETAIL
16	A	GUIDE BAR DETAIL
17	A	GUIDE BAR & SHIM DETAIL (A1)
17A	A	GUIDE BAR & RACK DETAIL
18	A	RACK & SHIM DETAIL
19		REMOVABLE SECTION CONNECTION DETAIL
20		REMOVABLE SECTION CONNECTION DETAIL

DRAWING INDEX

REVISION STATUS										
REV	D	C	B	D	D	A	B			
SH	1	2	3	4	5	6	7	8	9	10

REVISION STATUS BLOCK

Figure 9-5. Revision Status

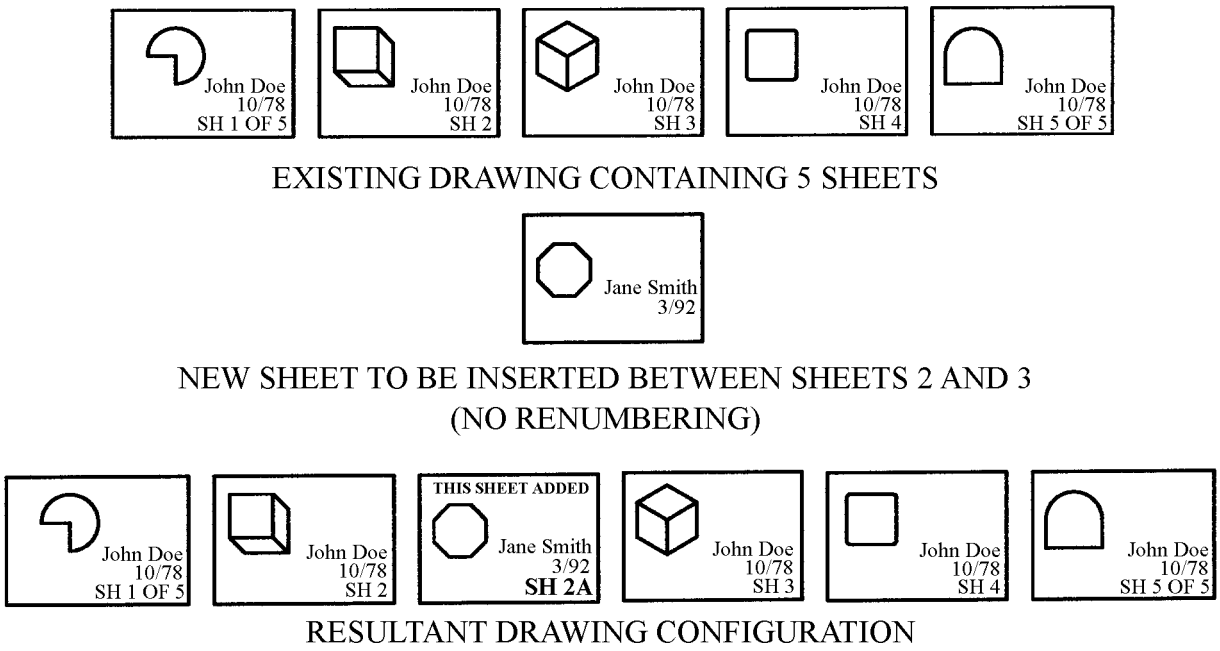


Figure 9-6. Insertion of a New Sheet

9.6.1.2 Adding Sheets to the End. Additional sheets added to the end of the drawing shall be assigned the next consecutive sheet number, without alpha letters, for each added sheet. The sheet number recordings on the first and last sheets of the drawing shall then be changed to reflect the first sheet and the new last sheet number, not the total number of sheets. The revision description of the new last sheet should read THIS SHEET ADDED or THIS SHEET ADDED PER EO-XX, as appropriate. The title block of a new sheet shall reflect the date the new sheet was approved and new signatures, in accordance with section II. Adding sheets to the end of a drawing requires a revision to the former last sheet of the drawing. For example (see figure 9-7), a 5-sheet drawing package has sheet 6 added to the end. Sheet 1 reads SHEET 1 OF 6, sheet 5 reads SHEET 5, and the new last sheet reads SHEET 6 OF 6. The revision description of sheet 6 reads THIS SHEET ADDED.

9.6.1.3 Inserting New Sheets and Renumbering. If one or more sheets are inserted and the entire drawing package renumbered, including alphanumeric sheets, the sheet numbers on the first and last sheets are changed to reflect the total sheet count (see 9.6.1.2). The title block of a new sheet shall reflect new signatures and the date the information on the new sheet was approved, in accordance with section II. The revision description of the new sheet shall reflect the new revision level and the description REDRAWN, NEW INFO. All subsequent sheets through the former last sheet number shall reflect the new revision level with the revision description reading REDRAWN, INFO WAS ON SHEET X. All information (drawing details, title block, revision data, signatures, etc.) on each subsequent renumbered sheet shall remain intact with only the

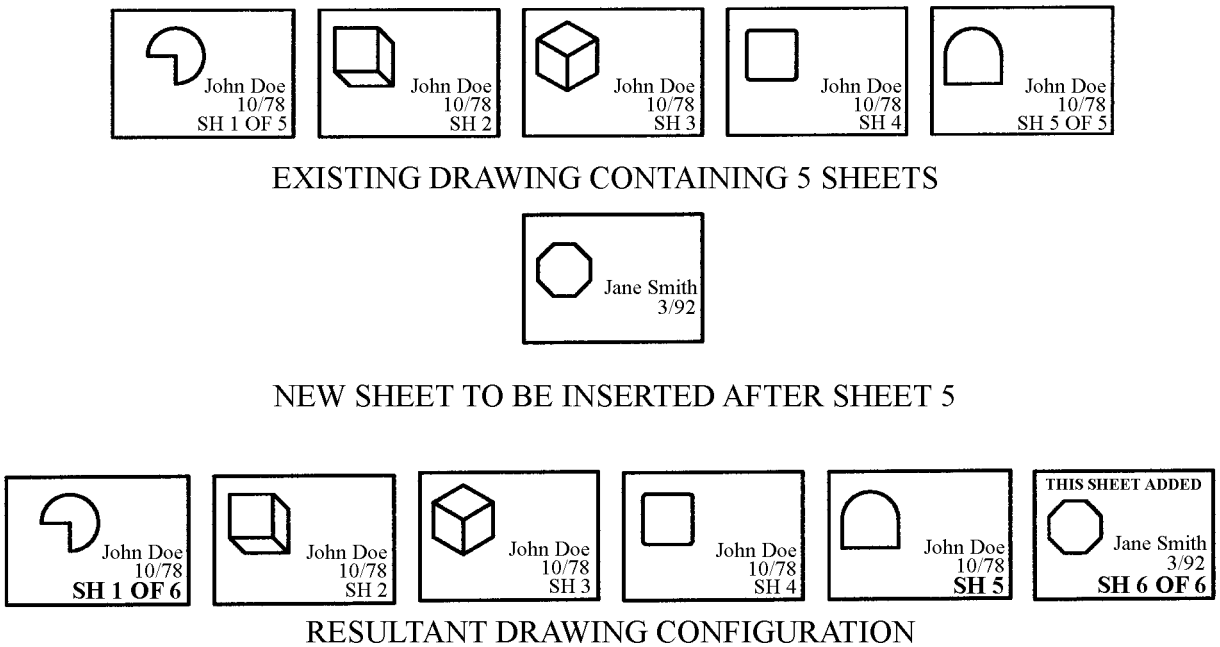


Figure 9-7. New Sheet Added to End of Drawing

sheet number being changed. The existing sheets that become sheets beyond the former last sheet number become added sheets with the revision description reading THIS SHEET ADDED, INFO WAS ON SHEET X. Any sheets with interconnect ballouts between sheets or details, sections, views, etc., between sheets, will be affected and shall be revised. For example (see figure 9-8), a 5-sheet drawing package has a sheet added between sheets 2 and 3 and is renumbered. Sheet 1 reads SHEET 1 OF 6. The new sheet receives new dates and approval signatures and becomes the new sheet 3 with the revision description reading REDRAWN, NEW INFO. The former sheet 3, in its entirely, becomes the new sheet 4 with the revision description reading REDRAWN, INFO WAS ON SHEET 3. Similarly, the former sheet 4 becomes the revised sheet 5, with sheet 5 now reading only SHEET 5. The former sheet 5, including the original signatures, is then added as a new sheet reading SHEET 6 OF 6 with the revision description reading THIS SHEET ADDED, INFO WAS ON SHEET 5.

9.6.2 DELETING SHEETS. Deleted sheets constitute a revision to the drawing. This revision shall be entered on sheet 1 of the drawing and in the drawing index if applicable. EO's applicable to deleted sheets (only) shall be cancelled per the same revision. Do not cancel EO's that affect both the deleted sheet and other sheets as well.

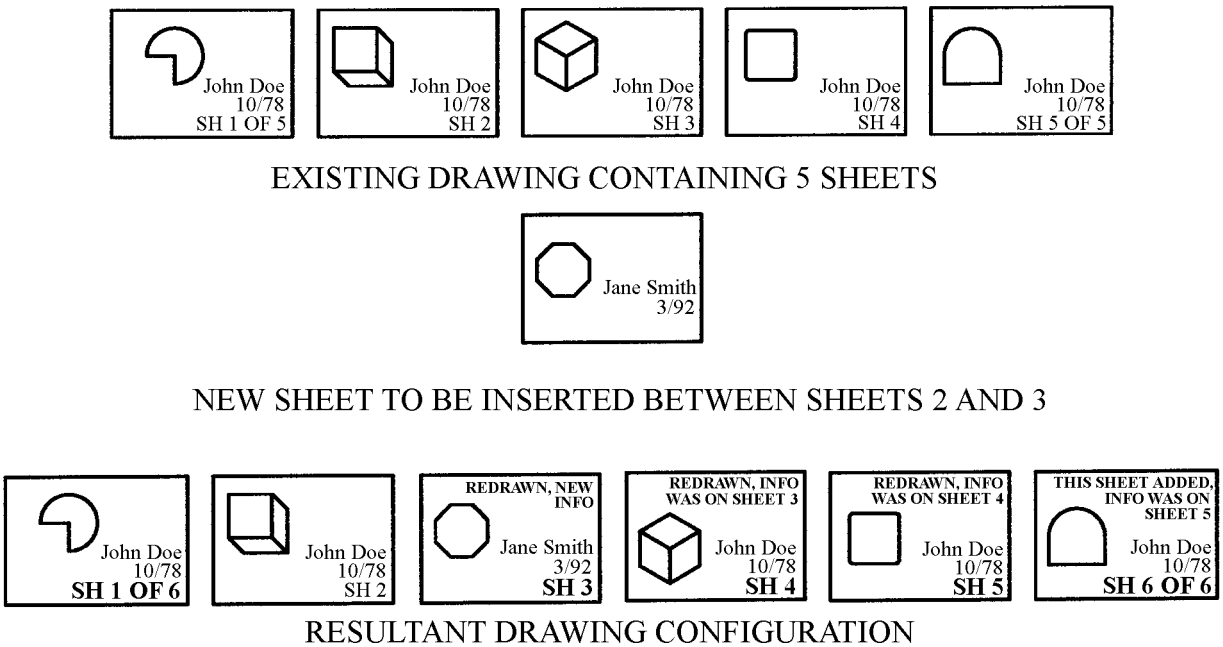


Figure 9-8. Insertion of a New Sheet With the Drawing Renumbered

9.6.2.1 Deleting Sheets Without Renumbering. Sheet 1 shall be revised to state the sheet has been redrawn. If any outstanding EO's apply to the deleted sheet (only), those EO's shall be cancelled per the same revision that deletes the sheet. The sheet shall be redrawn, and deleted information in the field of the drawing shall be indicated by large letters stating "THIS SHEET INTENTIONALLY BLANK." Update the index with the revision and remove the title of the sheet and replace with DELETED or INTENTIONALLY LEFT BLANK. (See Figure 9-9.)

9.6.2.2 Deleting Sheets and Renumbering. When sheets are deleted, the remaining sheets should be renumbered to retain the sequential order. The revision level of sheet 1 and each sheet that is renumbered shall be upgraded to the next revision level. The actual sheet being deleted cannot be defined by sheet number when renumbering since the sheet number will still be used. (See Figure 9-10.)

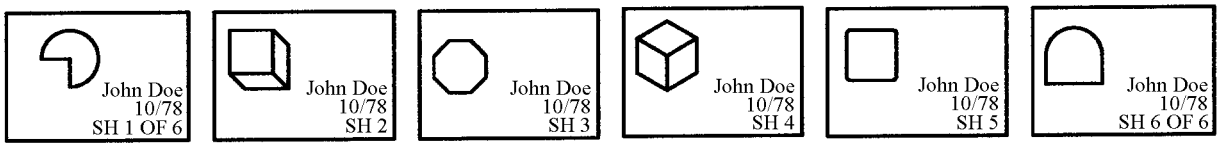
The sheet numbers at the end of the drawing that are no longer used due to renumbering shall be shown as the deleted sheets in the revision block on sheet 1.

When sheets are deleted, the word VOID shall be added to the original sheet above the title block, signed, and dated by the responsible organization representative, and submitted to the documentation center with the revised sheets of the drawing.

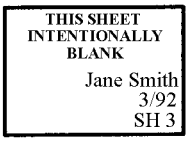
9.6.2.3 Reinstating Cancelled/Deleted Sheets. Reinstating a sheet constitutes a revision to the drawing on sheet 1 and the reinstated sheet. Sheet 1 shall state the sheet is reinstated. If the drawing was not renumbered at the time the sheet was deleted, then on that sheet it shall be stated: REDRAWN, NEW INFO. If the drawing was renumbered and sheet x is reinstated back

into the drawing where it originally existed, sheet x will be shown as REDRAWN, NEW INFO and the remaining sheets will be shown as REDRAWN, NEW INFO, WAS SHEET XX. Any new sheet numbers added to the end of the drawing shall read THIS SHEET ADDED, WAS SHEET XX on that sheet and on sheet 1. (See Figure 9-11.)

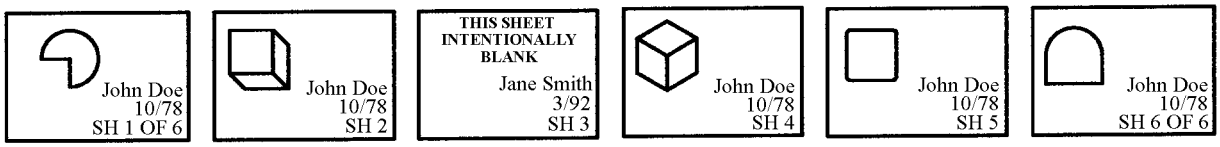
9.6.3 REARRANGING SHEETS. Rearranging sheets within a drawing shall constitute a revision to the drawing. The revision shall be entered on both the rearranged sheet and on sheet 1 of the drawing. Rearrangement of the sheets shall be accomplished by renumbering the sheets.



EXISTING DRAWING CONTAINING 6 SHEETS

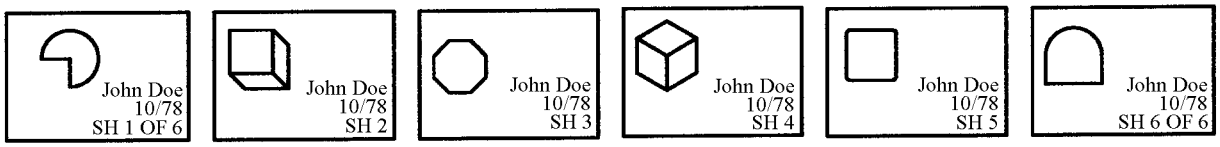


DELETE SHEET 3
(NO RENUMBERING)

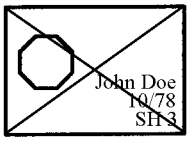


RESULTANT DRAWING CONFIGURATION

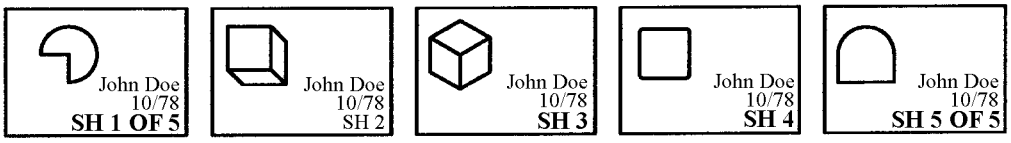
Figure 9-9. Deleting Sheets Without Renumbering



EXISTING DRAWING CONTAINING 6 SHEETS

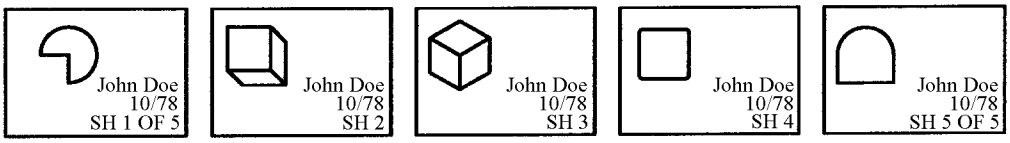


DELETE SHEET 3

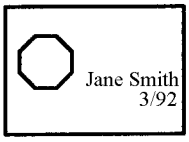


RESULTANT DRAWING CONFIGURATION

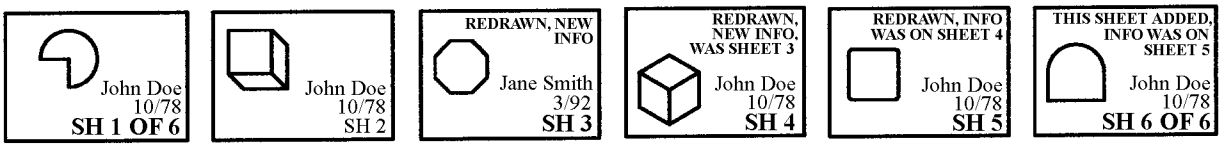
Figure 9-10. Deleting Sheets and Renumbering



EXISTING DRAWING CONTAINING 5 SHEETS



REINSTATING A CANCELLED/DELETED SHEET



RESULTANT DRAWING CONFIGURATION

Figure 9-11. Reinstating a Cancelled/Deleted Sheet

When the sheets are renumbered, the old sheet number shall be indicated in the revision block. (See figure 9-3.) Sheets that are rearranged between existing sheets or at the end of the drawing shall be added sheets in accordance with 9.6.1.

9.7 CANCELLED DRAWINGS

When drawings are cancelled, they shall be revised to the next higher revision level. The revision block shall be marked CANCELLED AND REPLACED BY 79K _ __ _ _ or marked CANCELLED AND SUPERSEDED BY 79K _ _ _ _ _. (See figure 9-3.) The cancelled drawing shall be approved and released at the same time or after the new drawing is released. Cancelled multiple-sheet drawings shall have only the first sheet revised and released. Sheets other than the first sheet shall be voided by adding the word VOID above the title block, signed and dated by the responsible organization representative, and submitted to the documentation center with the revised sheets of the drawing. All outstanding EO's and the reserved EO's of a cancelled drawing shall be cancelled by the documentation center on the Configuration Management Data System (CMDS). A drawing cannot be updated and cancelled at the same revision.

9.8 OBSOLETE DRAWINGS

When drawings are classified as obsolete, they shall be revised to the next higher revision level. The revision block shall be marked OBSOLETE with justification (as shown in figure 9-3), approved, and released. Obsolete multiple-sheet drawings shall have only the first sheet revised and released. Sheets other than the first sheet shall be voided by adding the word VOID above the title block, signed and dated by the responsible organization representative, and submitted to the documentation center with the revised sheets of the drawing. All outstanding EO's of an obsolete drawing will automatically carry the same status (OBSOLETE) as the drawing when entered on the CMDS by the documentation center.

9.9 REDRAWN OR REPLOTTED DRAWINGS

Drawings that are redrawn by manual, CAD, or photoreproduction methods shall be revised to the next higher revision with the appropriate information in the revision block, approved, and released. The revision blocks on manually and photographically reproduced drawings shall be marked REDRAWN NO CHANGE (as indicated in figure 9-3) or REPLOTTED NO CHANGE. It is not required to indicate REVISED AND REDRAWN in the revision block on CAD-revised drawings; however, the changes made by the revision shall be indicated. The original drawing sheets replaced by the redrawn or replotted sheets shall be marked VOID above the title block and signed by the responsible organization. All voided drawing sheets should accompany their revised sheets to the documentation center when the revised sheets are released.

9.10 REINSTATING A CANCELLED/OBSOLETE DRAWING

Reinstating a cancelled or obsolete drawing shall require the preparation and release of a new drawing with a new drawing number or the release of the same drawing number at a higher revision.

9.11 DOCUMENTATION FILES

Documentation files for drawing changes and revisions shall be maintained by the documentation centers. The latest released drawing revisions and all outstanding EO's shall be maintained in an active microfilm file.

Microfilm for incorporated EO's, previous revisions, and cancelled or obsolete drawings (except for sheet 1) shall be marked HISTORY and maintained in a history microfilm file.